Engineering News

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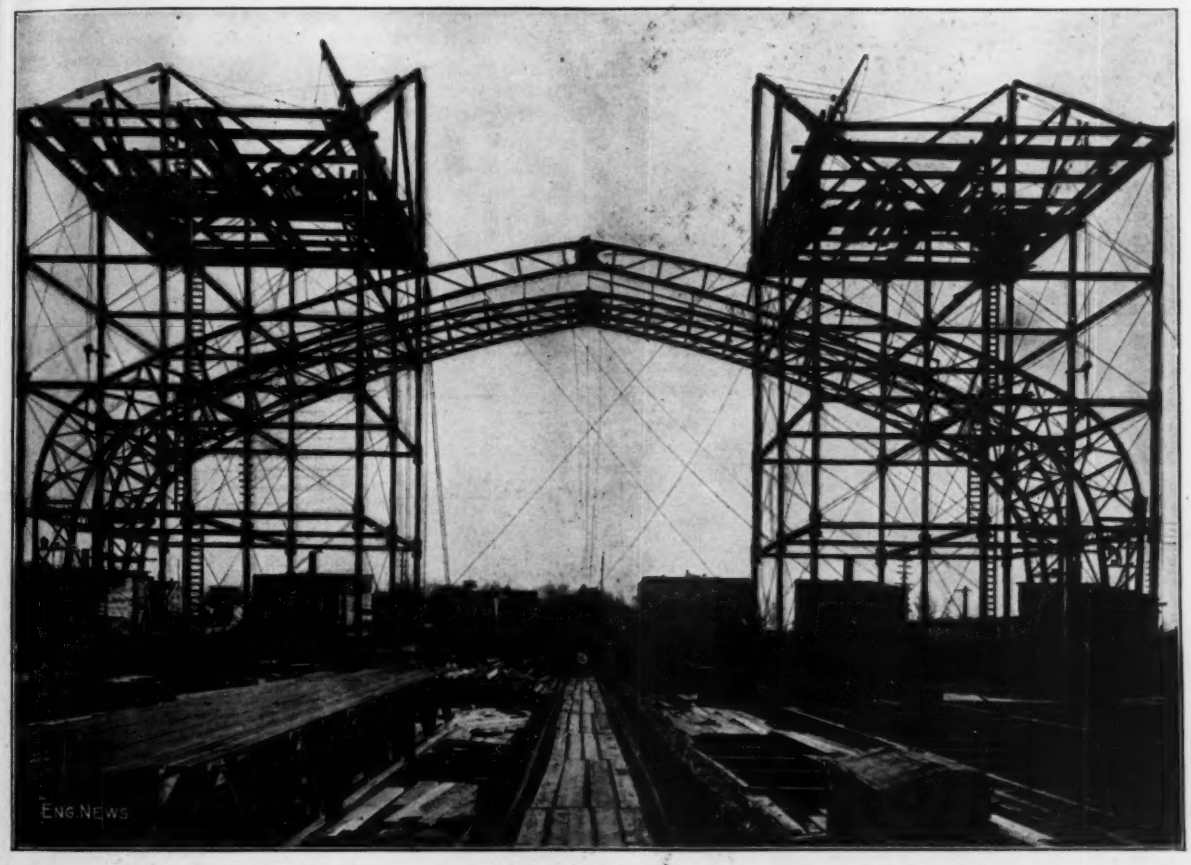
Steel Arch Erection for an Armory at Kingsbridge, New York City

A remarkably large armory is being built for the 8th Regiment of Coast Artillery (of the New York militia) at Kingsbridge Road and Claflin Terrace, New York City. It will have the largest drill hall in the world. Its arched roof of steel framing has a span of 288 ft. 10 in. and a rise of 102 ft. 7½ in. c. to c., and is 600 ft. long. Each of the arches weighs about 100 tons. Because of the size, shape and make-up of the steelwork unusual methods are being used in the erection work.



THE THIRD ARCH ERECTED, RIVETED AT THE HIPS AND PINNED AT THE TOP

The arches are three-hinged. Double-channel ties built in the floor of the drill hall (and serving as floorbeams) hold the opposite arch shoes against the arch thrust. The arches are set in pairs forming braced towers 10 ft. wide; the bay length between adjacent trusses of consecutive towers is 35 ft. A cantilevered balcony runs around the entire drill hall about 20 ft. above floor level, but does not interrupt the arch-web system or the tower bracing. The arch shoes are riveted steel, resting on cast-steel base slabs set on the granite caps of the foundation piers. These foundation piers were carried to rock.

The drill-hall floor is one tier above ground. Before work on the arches was begun, the columns and beams up to floor level, and the arch shoes and ties, were set by the two travelers provided for the arch-erection work; only the first story of each traveler was used in this preliminary erection. The work proceeded from the west end—where the material yard is located—toward the east, the travelers moving forward, each on three rails laid on sets of four 8x16-in. stringers, on the finished portion of the floor. This same trackway was left for the return movement of the travelers, the erection of the arch work progressing from east to west. A track for material cars, between the two traveler tracks, provided for bringing the steel forward from yard to point of erection.

HANDLING OF MATERIAL—A storage yard for the steel is arranged at the west end of the lot. The main storage yard is in Jersey City, and steel is brought by barge as required, to the foot of 238th St., and trucked from

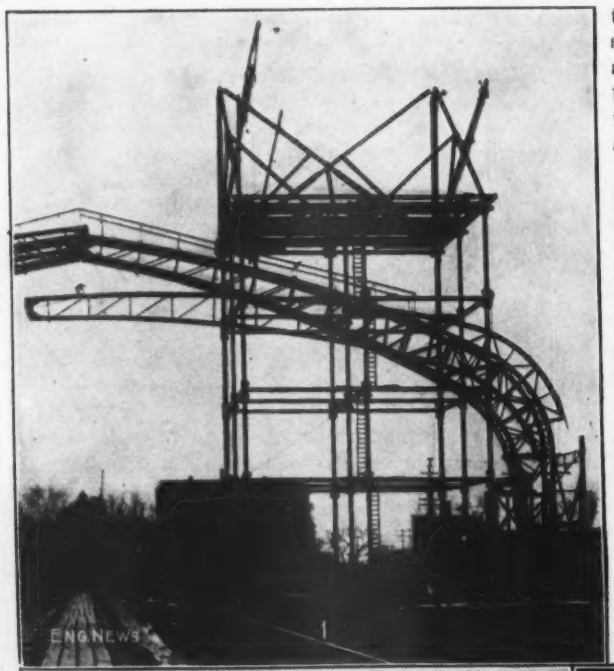
there to the yard at the site. A 20-ton wooden derrick with 50-ft. boom, 14x14-in., is set up in the yard, to handle the material in and out of storage.

Each half arch is built in five sections for shipment; the two haunch sections, containing the sharply curved part of the chords, are shipped knocked down (indicated in Fig. 4), but the skewback section or *hip* and the sections nearest the crown are shipped assembled. At the shop the arches are assembled complete, flat on the ground, and all connections drilled or reamed to match.

ERECTION SCHEME AND PLANT—The scheme of erection involves setting and shoring the hips, and then assembling the rest of each half-arch flat on the ground as a single erection piece and hoisting the two pieces simultaneously, setting them on the hip sections and making the crown-pin connection. Each hip weighs 12 tons, and the rest of the half-arch about 38 tons.

Two large two-boom timber derrick-towers, 60x60 ft. in plan and about 91 ft. high, handle the erection. The derricks are operated separately by 40-hp. steam hoisting engines (two Lambert and two Lidgerwood) in the bottom story of the tower. The front corner posts of the travelers are 14x14-in., the derricks coming immediately over them; the other posts are 12x12-in. The travelers are always so placed that in working position the front corner posts come directly over floor columns.

The derricks have 60-ft. booms made of a 16x16-in. timber backed by a 12x12, and 40-ft. masts of a 14x14-in. stick backed by a 12x14. The inside derrick on each traveler is lengthened 20 ft. (for raising the monitor steel) by two 8x16 side pieces 36 ft. long. These are clamped to the boom, to avoid weakening the boom by bolt holes. The three clamp-yokes are made with the bolted junction off the center line, so that the derrick lines will not foul the bolts.



RAISING RIGHT HALF OF THE THIRD ARCH

Fig. 1. Hoisting the half-arch. Fig. 2. Lowering the half-arch preparatory to entering the splice in the top chord. Fig. 3. Half-arch in position on the hip.

The travelers usually set two or three pairs of hip sections ahead of the main work, as their reach in any position permits. At the shoe pin, all parts engage the pin with jaw plates, requiring the pin to be driven. The arch tie has a field splice in the end bay, whose connection holes are left blank to give exact adjustment of length of span. The shoes are not bolted down, but are merely placed to exact position; when the pin is driven, the splice in the tie is drilled and riveted. The hip section is adjusted to true position by plumbing the outer face, which is vertical.

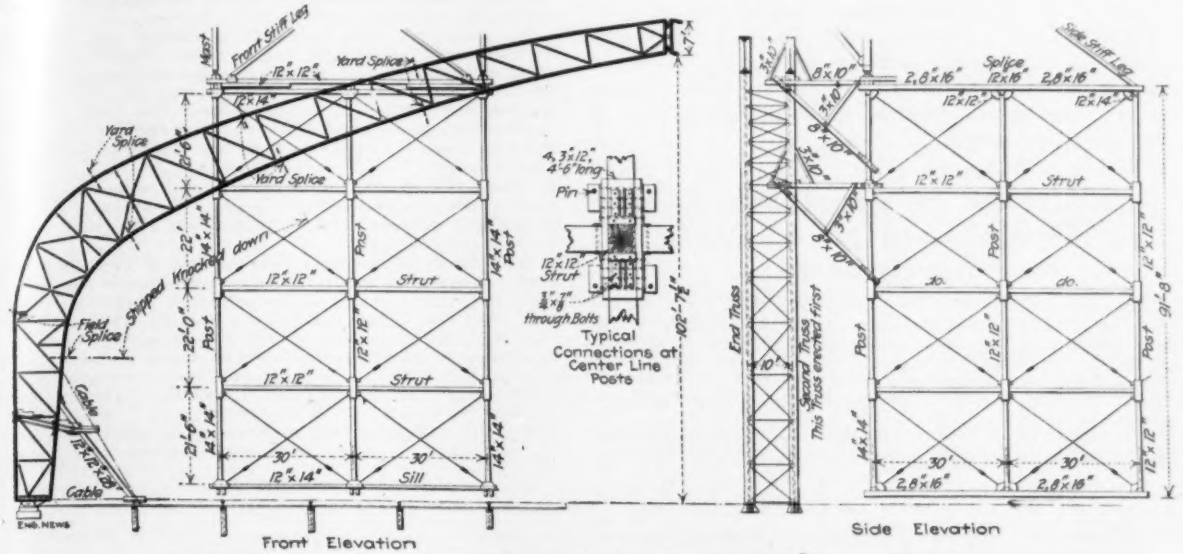


FIG. 4. ERECTION TRAVELERS; METHOD OF BRACING THE FIRST ARCH ERECTED

Assembling the half-arches is done in the position sketched in Fig. 5. The procedure is as follows: The section nearest the crown and the section next outside are laid down on blocking, and their splice drawn into tight

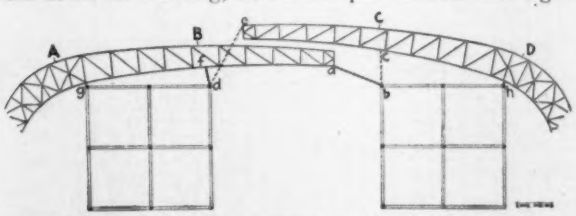


FIG. 5. PLAN OF TRAVELERS AND ASSEMBLY OF ARCH SECTIONS

contact; the loose web-member across the splice is placed and the connections drifted tight and bolted. Then the lower chords of the two haunch sections of each half-arch are laid approximately in place, their splices being entered as well as may be. The haunch web-members are then laid down and connected to the lower chords, and finally the top chords are entered; then the entire knocked-down portion is everywhere drawn together, and against the middle section, with steamboat ratchets, and when tight and snug everywhere the splices and web connections are drifted tight and bolted. Reaming the web holes where out of match follows—about 25% of these holes require some reaming—and then the whole is riveted.

HOISTING THE ARCHES—Like the assembling, the hoisting of the two half-arches is simultaneous. The two derrick falls of the left-hand traveler are hitched to the top chord of the left half-arch at points *A* and *B* (Fig. 5). Two block falls from the top corners of the same traveler are brought down to double-sling hitches to the lower chord at *g* and *f*; and a similar line from the right-hand traveler takes another hitch near the crown joint at *a*. The block falls are taken on the spools of the hoisting engines. All five lines hoisting together, the left half-arch is lifted about 20 ft. straight up, in flat position. Then the lines to the lower chord are slacked off while the derrick lines continue hoisting, and the piece is thus slowly turned to vertical or working position. The falls from the right-hand traveler can now be cast off, as the arch is amply stiff in this position. The right half-arch is thereupon similarly lifted (block falls *ba* and *df* are removed from the left half-arch and connected to points *c* and *e*, respectively, on the right half) and turned, the load or derrick hitches in this instance being at *C* and *D* and the block falls at *h*, *c* and *e*. Both halves are then ready for setting.

The half-arch when hoisted to place is first entered into the hip section at the top-chord splice. Holding this splice, the arch is gradually lowered to contact at the bottom-chord splice and—the other half-arch being in similar situation—to position for driving the crown pin. The load is held on the derricks, however, until the hip splices are drifted and bolted complete. The arch is braced to the previously erected work by setting the purlins. The travelers then proceed to erect the jack-rafters and the monitor steel, and are ready for the next arch. The tower bracing between the two arches of a pair is, of course, put in as soon as the second arch of the pair is in place. Bracing between towers occurs only in the two end bays of the hall, where it is needed to take the load from the elaborate end-framing of the drill hall.

In starting the erection, the first arch was braced to the derrick travelers, with supplementary guy ropes, instead of relying on guying alone. The inner arch of the first (easterly) pair was therefore the first to be erected. The sketch Fig. 4 illustrates the arrangement.

The Pittsburgh Construction Co., of Pittsburgh, Penn., is erecting this steelwork, as subcontractor under

the Conners Brothers Co., general contractor. The Cambria Steel Co. fabricated the steelwork. The Gunvald Aus Co. was the structural designer; Pilcher & Tachau, also of New York, are the architects for the Armory Board. The erection work is being handled by J. W. Ghilon, as superintendent, and Ira J. Freedman as resident engineer for the Pittsburgh Construction Co. The erection equipment was designed in the office at Pittsburgh, under C. C. Burgess, Chief Engineer. The entire steelwork of the armory amounts to nearly 8000 tons, of which the arch roof makes about half. Under normal weather conditions the erection proceeds at the rate of two arches per week.

Conditions of Employment and Compensation of Civil Engineers*

In January, 1913, the Board of Direction of the American Society of Civil Engineers appointed the undersigned a Special Committee "To Investigate the Conditions of Employment of, and Compensation of, Civil Engineers Throughout the Country; to Collect Statistics and Data in Reference Thereto and to Report the Results of Such Investigations to the Society."

In April a circular was mailed to the entire membership of the Society asking each to fill out a form stating specifically (1) his residence; (2) his age; (3) whether or not he is a technical graduate; (4) if a graduate, the year of graduation and the degree conferred; (5) the number of years he had been in active practice, and the character of such practice, whether Civil, Mechanical, Electrical, etc.; (6) the number of years he had been in responsible charge of work; (7) his present title, omitting names of corporations, municipalities, etc.; and (8) his yearly rate of compensation, whether from a salary or from income from private practice, or from both. He was asked to give in a somewhat more extended way the general character and extent of his professional work, and to make any other comments on personal or local conditions and as to the reasons governing the same.

This circular was mailed to 6850 persons, and in the Committee stated its belief that the membership of the Society was large enough to be representative, and to be typical of the various stages of engineering life. It was stipulated that the information given would be regarded by the committee as strictly confidential, members not being asked to sign their statements, and that the replies when they had served their purpose would be destroyed.

To carry out this agreement, a number was placed indiscriminately opposite the name of each member on a mailing list. When all were mailed this list was sealed. Records of the numbers on the envelope of each reply received were kept so that later a new unnumbered list could be made, showing simply by check marks the names of those who did not answer. This was done and the original list destroyed.

There is a great deal of information on the original replies, which your Committee hopes to use in preparing a later report, but as soon as they have served this purpose they will also be destroyed.

About 3900 replies were received, and of these 3636 were filled out in such a manner as to be available for the work of the Committee. A diagram is presented herewith covering these 3636 replies in the following manner: Those who have been in active practice one year are grouped, then those who have been in active practice for two years, and so on. For each of these groups, the minimum, maximum and average yearly compensations are plotted, and the points connected to form curves.

The average curve errs, if anything, in being slightly too low, because in a number of cases the salary is given, and it is stated that in addition the member receives expenses, house-rent, share of profit of firm, sustenance, etc., and the salary figure has been used.

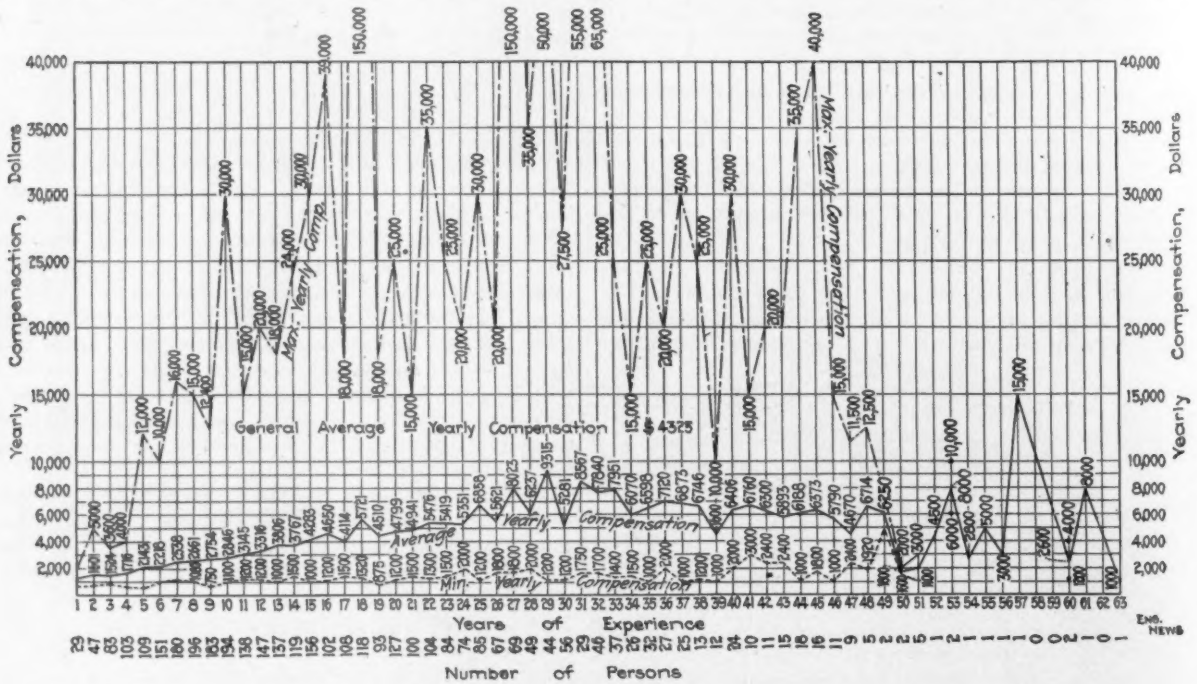


DIAGRAM SHOWING THE YEARLY COMPENSATION OF 3636 MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

In a general way, the diagram shows that, starting with the first-year group, the average remuneration is $1300, and that a surprisingly uniform increase is developed. At the end of five years the average rate of compensation is $2000; at the 11th year $3000; at the 15th year $4000; at the 21st year $5000; at about the 25th year more than $6000; reaching the highest general average of about $7500 between the 27th and 33rd years of practice. After that period the average rate of compensation gradually decreases, remaining, however, above $6000 up to the 45th year.

From that point the curve is very irregular, and after the

*Slightly condensed from the Report of the Special Committee of the American Society of Civil Engineers presented at the annual meeting of the society, Jan. 21, 1914.

47th year is practically of no value as an average on account of the small number of replies received. This small number is not surprising, however, inasmuch as these practitioners must be at least 70 years old.

It will be noted that in each group there is always one individual whose rate of compensation is far below the average, but that in all the groups up to 40 years of active practice, the yearly minimum rate is always below $2000, except in four instances, when it just reaches that figure.

The maximum rate of compensation for each group naturally varies greatly, but attention is called to the fact that in two cases it reaches $150,000 for purely professional remuneration.

The general average compensation for the 3636 members is $4325. It is an interesting fact also that for the first fifteen years the average yearly compensation of the 1972 who replied is $2827. Of the total 3636, just 25% are not graduates of technical schools.

An attempt was made to present the matter from a slightly different point of view, by drawing a curve representing the compensation received by the middle man of each group, that is the compensation exceeding, and exceeded by, that of an equal number of men; but while it may be stated that the compensation of this middle man is, in most of the groups, less than the average for that group, such irregularities appeared that the Committee withholds the result for further study.

An effort was also made to produce a diagram which would show the relative rate of compensation in various geographical sections, as follows: New England States, Middle States, Southern and Gulf States, Central States (north of Ohio River), Western States, and Foreign, but the groups thus made were too small to produce any reliable averages, and the attempt was abandoned.

ALFRED NOBLE, JOHN A. BENSEL, S. L. F. DEYO, C. F. LOWETH, GEORGE W. TILLSON, Committee.

New York City, Nov. 20, 1913.

Proposed Additional Water-Supply for Paris, France

At the present time the water-supply of the city of Paris, aside from the water from the River Seine, which is employed for street cleaning and for certain industrial use, is furnished from four separately built systems each taking from a spring-water or river source. These systems, with the date of their installation and their daily capacities, are as follows:

	Gallons
Dhuis, 1855	4,000,000 to 6,000,000
Vanne, 1874	25,000,000 to 30,000,000
Avre and Vigne, 1893	15,000,000 to 28,000,000
Loing and Lulain, 1900	15,000,000 to 18,000,000
Total	59,000,000 to 82,000,000

In addition to this service there are two installations on the outskirts of Paris furnishing filtered river water, which in 1912 supplied 19,000,000 gal. per day, but which have recently been delivering, with the aid of an ozonization plant at Saint Maur, a total of 35,000,000 gal. per day. There is also at the Ivry plant an emergency equipment extension in course of construction which will increase the emergency capacity to 50,000,000 gal. per day. In spite of all this, in the summer of 1911 at the end of a long hot spell the city was forced for several weeks to install emergency hypochlorite plants taking water from the River Marne.

Meanwhile the consumption of water in Paris is increasing very rapidly, more rapidly in fact than in most American cities because the number of bathrooms and other water services in the past have not been as great as in the ordinary American communities. It is estimated that the daily service in 1915 will be about 83,000,000 gal.; in 1920, 100,000,000 gal.; in 1940, 225,000,000 gal. This is the mean value, which will be increased by 30 to 40% in times of prolonged hot weather. In preparation for the increase which will be needed within the next twenty years, the city authorities have already begun a series of investigations looking into additional sources of supply.

The first of these, the investigation for which was made some years ago and the authorization for which is now in the hands of the French national government, having been adopted already by the city government of Paris, is a project taking additional supply from the Loing and Lunain supply, noted above as the latest of the present systems. The new supply adds to the present 18,000,000 gal. per day about 45,000,000 gal. per day by taking in an additional drainage area near the city of Nemours. It is a surface supply pumping into an aqueduct leading to the city. When this is completed the supply will be guaranteed up to 1920, but for the needed capacity beyond that date new studies have been made.

These studies were reduced to four projects. The first two were for surface supplies pumping into aqueducts, but were rejected either because not enough water was provided, or because the supply was contaminated and would require considerable filtration. The third and fourth projects were considered for a long while as equally possible. They were, respectively, the utilization of Lake Geneva and the utilization of a ground-water supply in the valley of the Loire.

The former scheme consisted in taking the water of Lake Geneva, where it is found in practically illimitable quantity and carrying it to Paris in an aqueduct about 300 miles in length. The water would take from three to five days to cover the distance. Three different schemes for utilizing this supply were advanced, two under gravity and one under pumps. This scheme was rejected, however, partially on account of the unsatisfactory nature of the water which probably would have required purification, but, mostly because of the great disance the aqueduct had to be carried and the difficulty in tunneling through some of the country which it had to traverse.

The last and adopted project consists in the utilization of the ground water in the valley of the Loire River lying between Nevers and Briare. This district, known as the Vals de Loire, has a length of about 54 miles and an average width of about 1 mile. The subsoil is made up of alluvial sand reposing on a compact base and is extremely water-bearing. Wells and borings driven by the city engineers showed a clear, pure water at distances from about 5 ft. below the surface of the ground extending to the hard strata some 20 ft. below. The water is excellent from a bacteriologic standpoint, rich in silica, poor in nitrates and contains some little manganese. Before reaching this location the water passes through a sandy formation especially advantageous for filtering, which accounts for the purity of the water.

The scheme for the utilization of this water has not been worked out, but it is intended to sink a number of wells and to drive galleries leading to the conduit through which the water can be pumped to Paris. It is expected that 250,000,000 gal. per day can be easily taken from this natural subterranean reservoir.

The total expense of the work is estimated at about $60,000,000 for the supply, and $20,000,000 additional for the distribution system needed in Paris. The project has been recommended to be adopted to the municipal council by a commission appointed to study into the question.

Broken Shore Bulkheads and Coast Erosion by the Recent Ocean Storms

We supplement our account of the damage done by the recent coast storms at Seabright, N. J., on p. 102 of our last issue, with views showing further typical cases of the destruction of bulkheads and shore property.

The upper view shows the land side of a shore bulkhead in which a breach has been battered by the surf. The waves entering this breach have washed away the sand from behind the bulkhead, and from under the boardwalk.

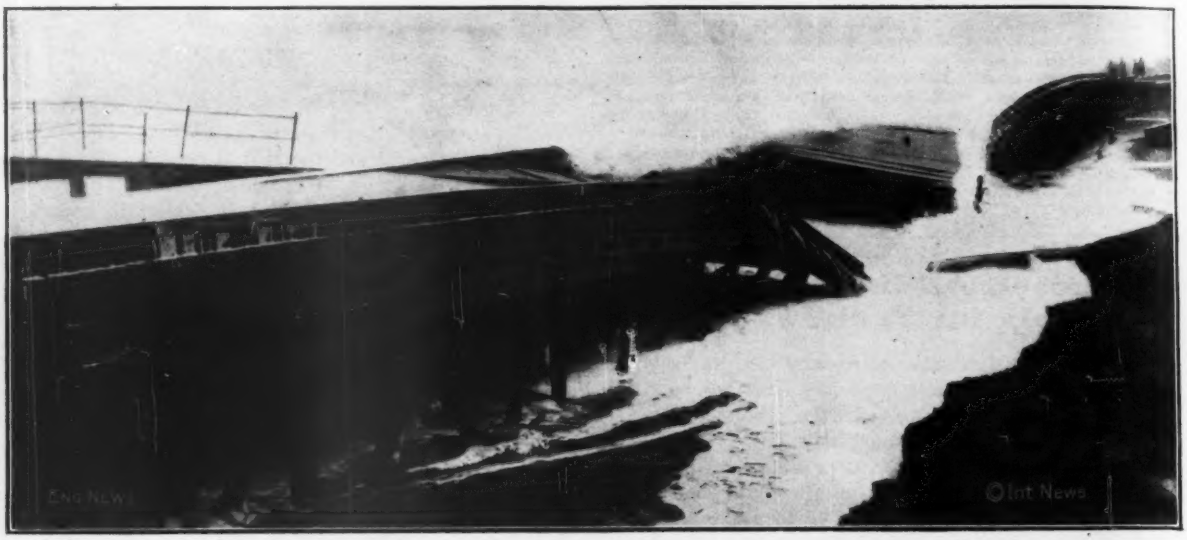
At the left of the lower view a small portion of a shore bulkhead still stands, but the remaining part has been swept away, exposing the buildings back of it to undermining and battering by the surf.

The Prevention of Storm Damage to Shore Lines

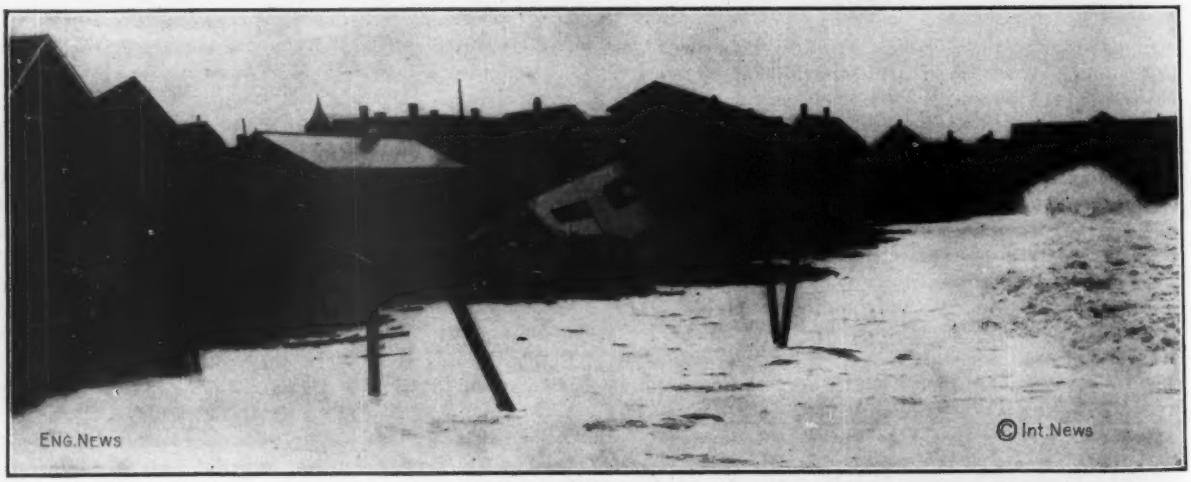
By Rudolph Welcker*

The recent storms which caused extensive damage along the coast of New Jersey and Long Island emphasize more than ever the necessity of protective measures to combat the retrogressive movement of the coast line. Generally such occurrences are only considered as local and separate events. The damage is patched up by the abutting owner for the time being, independently from his fellow sufferers. Sometimes a certain number of them come together and devise some kind of temporary relief. However, their measures do not go to the heart of the matter at all. The cause of the recurrent trouble lies much deeper and well below the water line.

*33 Lyman St., Springfield, Mass.



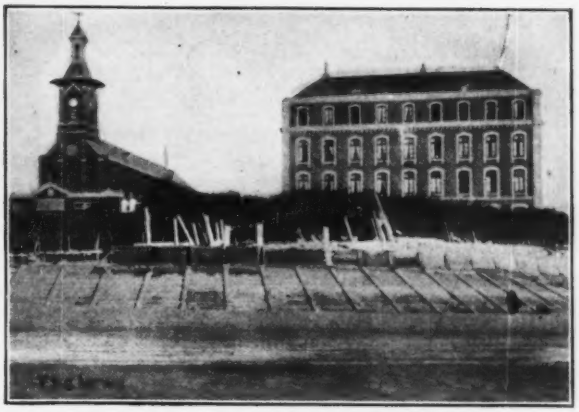
Section of the Bulkhead Wrecked by the Waves



Typical Damage to Buildings after the Bulkhead Was Destroyed

VIEWS SHOWING DAMAGE ALONG THE NEW JERSEY COAST BY THE STORM OF JAN. 4

FIG. 1. REINFORCED-CONCRETE GROIN AS SHORE PROTECTION IN HOLLAND



FG. 2. SHORE PROTECTION, PAS DE CALAIS, FRANCE

The tidal currents, driven up and down the shore at regular intervals during the day, are continuously changing the character of the submarine coast, wherever the ocean bed is liable to erosion. In consequence of this action, the lines of equal depth will be shifted. In some places they will encroach upon, in others they will recede from the main land. Different motions may be studied. Some depend upon the season, some upon the prevalence of certain winds. Some movements are periodical with intervals of a number of years; others, however, are permanent. Their cause is a matter of speculation.

How far similar action must be taken along the New Jersey and Long Island coast for adequate protection can only be decided after exhaustive study by properly qualified engineers. No permanent result can be attained by the piecemeal constructions of individual owners. They will find the sea too powerful to combat single handed; and what may appeal in a stronger measure is the waste of money in their efforts.

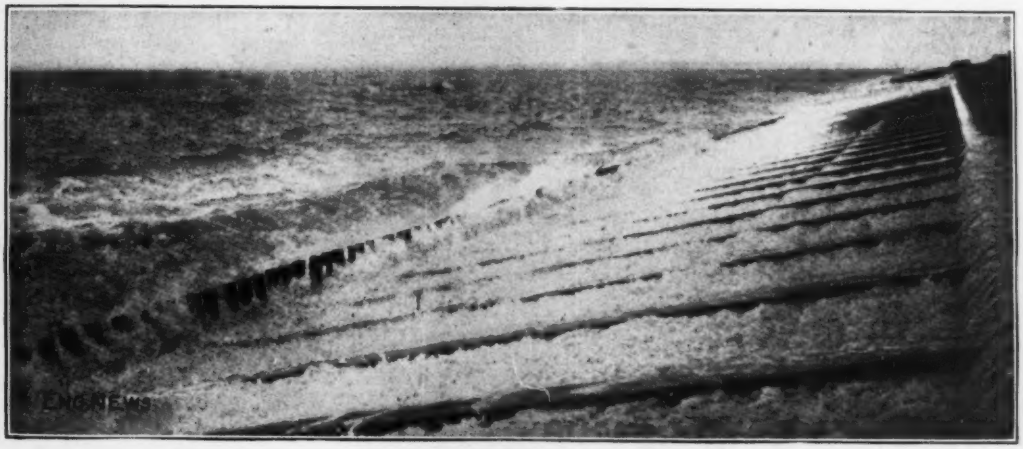


FIG. 3. SMALL STORM BREAKERS ON SHOREWALL

In order to demonstrate the latest case of a permanent retrogressive movement of the shore line, we can only point to the west coast of Holland, which has receded for miles during the time of human history. The foundations of the Roman stronghold, the Brittenburg, were seen for the last time during an unusual low tide in the middle of the last century. They were observed lying some miles to westward of the present coast line of the North Sea. To stop this encroachment has been a continual care to the Dutch government and the abutting interests. For the last twenty years, measures have been effective by the general application of what is called the fixed-point theory.

This system calls for a series of groins or piers which stretch well beyond the line of low water and extend at the present time for a number of miles along the coast. One is shown in Fig. 1. These groins have been effective in checking the eastward movement of the low-water line. In some places additional structures are required for the defense of the toe of the sand dunes; Figs. 2 and 3 give examples on the coast of France.

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Railroad Casualties on the Western R.R. of Massachusetts in 1845—Little items like the following sometimes illustrate railway-operating conditions and equipment in the primitive days of the railway far more vividly than a weighty treatise:

Last week was certainly a very unlucky one with the trains on the Western railroad. We have already recorded the collision of the first freight train on the morning of the 7th, with a yoke of oxen at Westfield, by which one animal was killed outright, and the other hurt so much that it was obliged to be sacrificed, besides throwing the locomotive, tender and ten freight cars off the track and damaging them quite seriously, as well as delaying all the trains of the day. On Saturday (8th) one freight train ran into the rear of one forward of it, while the latter was stopping at the Chester Factories depot, by which the locomotive of the first train was injured to the amount of $2000, and five cars of the last broken to pieces, and their contents of live hogs let loose too violently for their comfort. Five of them were killed. On Friday (7th) a passenger train ran over and killed two cows west of Pittsfield; the locomotive was not injured nor the train thrown off; and on the same day a flock of sheep were run into by another train, and some twenty or more killed. Quite a slaughter house, truly! including the ox run over and killed on the Friday previous (Oct. 31st), last week's work would sum up: Three oxen, two cows, five hogs and sheep too numerous to mention, without saying anything about the locomotive, cars and freight smashed up, all of which somebody must pay for. Most fortunately no person was hurt by either accident.—"Springfield Republican." Nov. 13, 1845.

Alternate Designs for New James River Bridge, Richmond, Va.

In March, 1913, the Administrative Board of Richmond, Va., advertised a competition for the design of a concrete bridge across the James River on the site of the old Free Bridge, which on the Richmond side of the river is at about Ninth St. After considerable delay, and a variety of conflicting circumstances, all of which have been stated in these columns, the award of prizes was made August, 1913.

Some thirty engineers submitted designs for the structure. A collation of all of these designs would be very instructive as showing different solutions of the same problem, but it is beyond the space which we can allow. We have, however, secured the drawings submitted by the three prize winners, together with brief explanations of their respective reasons for the designs which they submitted. It is interesting to note that these three designs are of different types of bridges, that is, as far different as the restrictions of the competition would allow. The first prize of $1500 awarded to B. H. Davis, of New York City, is for a series of long-span, rather flat, elliptical reinforced-concrete arches. The second prize of $500, awarded to R. A. Cummings, of Pittsburgh, is for a series of short-span, semicircular concrete arches; while the honorable mention awarded to Messrs. Scarborough and Roelker, of Richmond, Va., is for a reinforced-concrete beam-and-column viaduct.

The requirements of the competition were very simple, so simple in fact that the competitors were seriously handicapped in their effort to meet the views of the Board as to the type and cost of the bridge. The requirements were that the bridge was to be erected on present Free Bridge site; that the bridge and the approaches were to be designed of reinforced concrete, of such construction as to provide and care for the heavier traffic loads for municipal service and for street cars of an estimated weight of 60 tons each; that the bridge and approaches were to be not less than 60 ft. wide and the roadway not less than 44 ft. wide, exclusive of sidewalks and including railing. The termini of the bridge and of the approaches were definitely shown on a map. Further requirements were stated for the type of sidewalks, trolley and light poles and conduit and sewer provisions. It was stated that the bridge must be of such design as to vent readily the river flow at the highest record, which was shown on a submitted plan. This plan also gave the grades of the old bridge and streets, and the general statement that the new bridge must clear the Chesapeake & Ohio R.R. tracks on the Richmond side of the river by at least 22 ft. No prescriptions as to cost or architectural treatment were made. One very important error in the requirements is the stipulation that the bridge approaches on the Richmond side reach grade at Byrd St., which is some distance toward the river from a grade crossing with 16 railway tracks, over which all traffic to the bridge would go. Nearly every competitor called attention to this error in layout, but as a rule the restrictions of the advertisement were adhered to. It will be noted, however, that the last design herewith shown avoids the grade. The accompanying figures give the general and detail elevations, sections and plans of the three premiated designs.

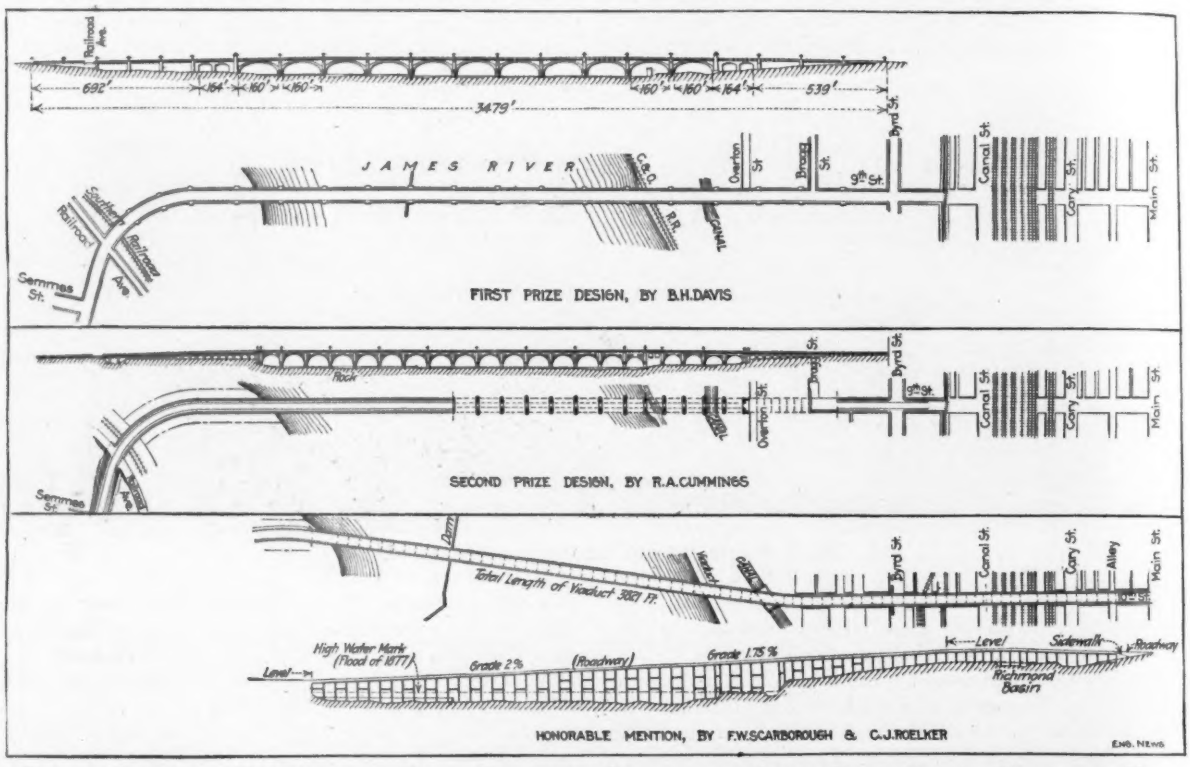

FIG. 1. PLANS AND ELEVATIONS OF THREE PREMIATED DESIGNS FOR JAMES RIVER BRIDGE, RICHMOND, VA.

FIRST-PRIZE DESIGN

The first prize was awarded to B. H. Davis, of New

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For the sake of economy of construction, the proposed new bridge was designed to straddle the old structure, which, with its cantilever sidewalk removed, will form an ideal construction trestle with standard-gage tracks already in position for construction operation. The piers, however, do not coincide with any of the piers of the old bridge. This, then, controls the alignment. The grade was fixed by the requirements of clearance over the various railway and canal properties. The long spans of the main bridge were decided upon to clear the railway properties at the shore parts of the bridge and were continued across the river at the same span length, partly for aesthetic considerations, but mainly for economic reasons, the saving in forms and centers for a series of equal-span arches being quite large.

For a short distance at each end of the structure, the approaches consist simply of retained fills, but these give way to floor-slab and curtain-wall construction where the depth of fill becomes excessive and the retaining-wall section correspondingly extensive. Each approach contains, next to the river section, two 56-ft. spans of the arch-girder type, the approach spans being made up of deep narrow girders of segmental form, each having sufficient rise to act as an arch. The bridge itself will consist of a series of eleven semi-elliptical arch spans each 160 ft. long and 40 ft. high, surmounted by segmental spandrel arches. Each of the long-span arches is composed of two parallel arch ribs 4½ ft. thick at the crown by 14 ft. in width and reinforced, mainly against temperature and construction stresses; they are 20 ft. apart, for the whole length, and the floor, a reinforced-concrete slab, is carried on reinforced-concrete girders spanning this 20-ft. opening. Sidewalks are to be carried on projecting cantilevers.

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The design by Robert A. Cummings, of Pittsburgh, Penn., shown in the middle of Fig. 1, was awarded second prize. Messrs. Rutan and Russell were consulting architects. This design consists of a series of short-span concrete arches flanked by retained fill approaches. The general features of the design and an explanation of its fundamentals are set forth in the following extracts of a brief presented by Mr. Cummings to the Administrative Board.

It is essentially an engineering task to secure economical construction for the structural solution of the problem. The first consideration in any design for this bridge is the fixing of the grade line for the roadway. According to the "Requirements" the elevation of each terminus is fixed and there must be a 22-ft. clearance over the right-of-way of the C. & O. R.R., which is located along the north shore of the James River.

My design fixes the grade of the roadway over the C. & O. R.R. at elev. 90. Consequently, the Richmond approach will have a grade of 0.75%. Inasmuch as there is an insignificant saving in the quantities of work in the use of a regular roadway grade over a broken grade from the C. & O. R.R. to the southern terminus, and as a regular grade line would not harmonize with the adjacent structures (railroad bridges, etc.) nor conform to the two last mentioned principles of design, a level grade at elev. 90 for the river crossing was adopted.

Further reasons for a level river crossing are found in the advantage of securing uniformity in construction; and in harmonizing the grade line of a prominent and elevated structure with the horizon and the water level of the river. Besides, the obvious purpose of the bridge is the crossing of the river and railroad and this is emphasized by the grades used.

In the final design there should be a certain "crowning" of the longitudinal level grade so as to avoid the optical illusion of depression at the center, but which is not shown in the drawings.

A study for the design was made with a view of securing the most economical type. That is, the type of bridge in which is combined all engineering requirements for strength, economy of materials, facility in construction, and the requirements of the Administrative Board.

The open-spandrel arch-rib type of span is best adapted to meet this problem. The present piers being in good condition, but too small, were utilized by being inclosed in the new bridge piers. Hence the present piers largely fixed the location of the new ones. It was further contemplated to utilize the present piers and bridge during construction by placing the arch ribs on either side of them.

A gravity retaining wall will be built at the shore end on the Richmond side of the bridge and behind this wall will be an earth filling compacted to grade and suitably drained. The remainder of the Richmond roadway approach will be carried upon an ordinary type of reinforced-concrete slab, beam, girder and column floor system. In each bent there will be six columns 24 in. square connected by a girder at the top having arched brackets braces. The bents are 30 ft. c. to c. and located so that there remains an unobstructed entrance to the warehouses and factories on this section. The floor slab is 6 in. thick, the present beams are 20 in. wide by 40 in. deep under the soffit.

The intermediate section between Overton St. and the C. & O. R.R. crossing is composed of uniform span ribbed arches, similar to those described later for the river crossing, except that the spandrel walls are solid. The floor system of the roadway is similar to that of the river section.

One of the controlling requirements of the design is the securing of the lowest practical elevation of the roadway over the right-of-way of the C. & O. R.R. with a minimum clearance of 22 ft. above the top of present rails. This has been effected by adopting a slab and girder floor system having eight girders spanning the entire right-of-way and resting upon suitable supports. The obliquity of the right-of-way with the center line of the bridge in 60°, which complicated the problem and necessitated special treatment by a tunnel-like opening through the Richmond abutment.

The James River crossing consists of 13 spans of 90 ft. in the clear and two spans of 72 ft. in the clear, with appropriate terminal abutments. Each arch span consists of four semi-circular ribs 2 ft. 6 in. thick at the crown and 5 ft. thick at the springing line. At the crown the two outside ribs are 5 ft. in width, and the inside ribs 6 ft. 6 in. wide. Each rib is increased in width at the rate of 1 in 45 measured vertically from the crown to the springing line. Each outside and inside rib is connected on the soffit by a 6-in. slab and two streets located at points equidistant from the crown. Uniformly located on the arch ribs, is an open spandrel colonnade consisting of 8-ft. semicircular arches and columns which support the floor system carrying the roadway, street railway, sidewalk and handrail.

The slab is 6 in. thick and transverse girders are 20 in. by 40 in. spaced 10 ft. c. to c. The street railway is located directly over the interior ribs, (Fig. 2) and alongside the sidewalk for the greater convenience of pedestrian traffic on such a long structure. This also avoids danger from traffic that is always present when boarding cars located in the middle of the street.

Alternate Designs for New James River Bridge, Richmond, Va.

In March, 1913, the Administrative Board of Richmond, Va., advertised a competition for the design of a concrete bridge across the James River on the site of the old Free Bridge, which on the Richmond side of the river is at about Ninth St. After considerable delay, and a variety of conflicting circumstances, all of which have been stated in these columns, the award of prizes was made August, 1913.

Some thirty engineers submitted designs for the structure. A collation of all of these designs would be very instructive as showing different solutions of the same problem, but it is beyond the space which we can allow. We have, however, secured the drawings submitted by the three prize winners, together with brief explanations of their respective reasons for the designs which they submitted. It is interesting to note that these three designs are of different types of bridges, that is, as far different as the restrictions of the competition would allow. The first prize of $1500 awarded to B. H. Davis, of New York City, is for a series of long-span, rather flat, elliptical reinforced-concrete arches. The second prize of $500, awarded to R. A. Cummings, of Pittsburgh, is for a series of short-span, semicircular concrete arches; while the honorable mention awarded to Messrs. Scarborough and Roelker, of Richmond, Va., is for a reinforced-concrete beam-and-column viaduct.

The requirements of the competition were very simple, so simple in fact that the competitors were seriously handicapped in their effort to meet the views of the Board as to the type and cost of the bridge. The requirements were that the bridge was to be erected on present Free Bridge site; that the bridge and its approaches were to be designed of reinforced concrete, of such construction as to provide and care for the heavier traffic loads for municipal service and for street cars of an estimated weight of 60 tons each; that the bridge and approaches were to be not less than 60 ft. wide and the roadway not less than 44 ft. wide, exclusive of sidewalks and including railing. The termini of the bridge and of the approaches were definitely shown on a map. Further requirements were stated for the type of sidewalks, trolley and light poles and conduit and sewer provisions. It was stated that the bridge must be of such design as to vent readily the river flow at the highest record, which was shown on a submitted plan. This plan also gave the grades of the old bridge and streets, and the general statement that the new bridge must clear the Chesapeake & Ohio R.R. tracks on the Richmond side of the river by at least 22 ft. No prescriptions as to cost or architectural treatment were made. One very important error in the requirements is the stipulation that the bridge approaches on the Richmond side reach grade at Byrd St., which is some distance toward the river from a grade crossing with 16 railway tracks, over which all traffic to the bridge would go. Nearly every competitor called attention to this error in layout, but as a rule the restrictions of the advertisement were adhered to. It will be noted, however, that the last design herewith shown avoids the grade. The accompanying figures give the general and detail elevations, sections and plans of the three premiated designs.

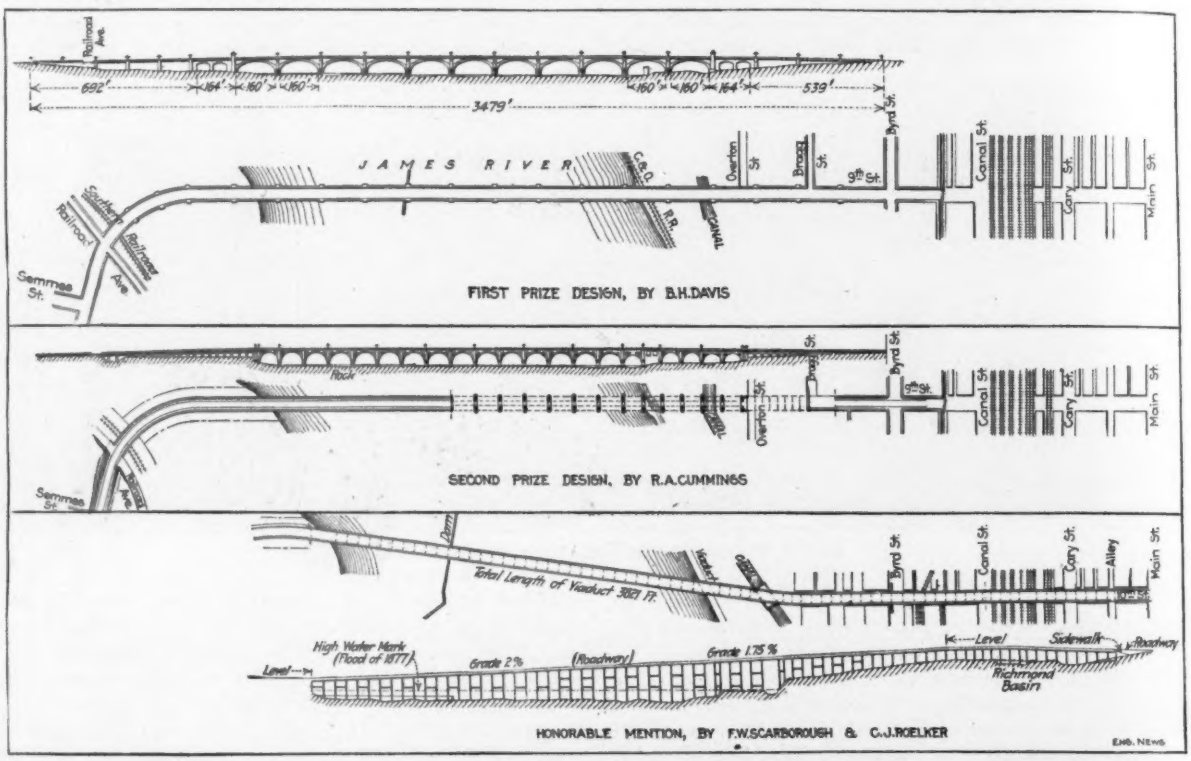

FIG. 1. PLANS AND ELEVATIONS OF THREE PREMIATED DESIGNS FOR JAMES RIVER BRIDGE, RICHMOND, VA.

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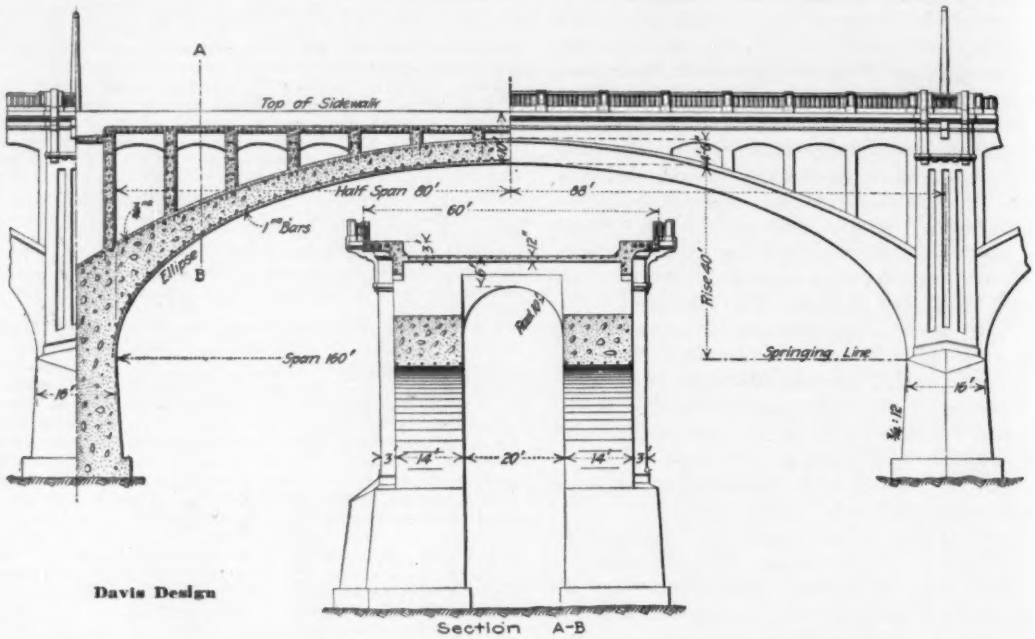
The south approach is similar in design to the floor system and supports of the Richmond approach and comprises the section between the James River crossing and the North line of Railroad Ave. The section between Railroad Ave. and Semmes St. will consist of an earth embankment properly graded and paved.

The estimated cost is approximately $475,000. This is based upon similar work in the vicinity. It is believed that in the structural solution of the problem the first object of engineering skill has been secured in an economical construction.

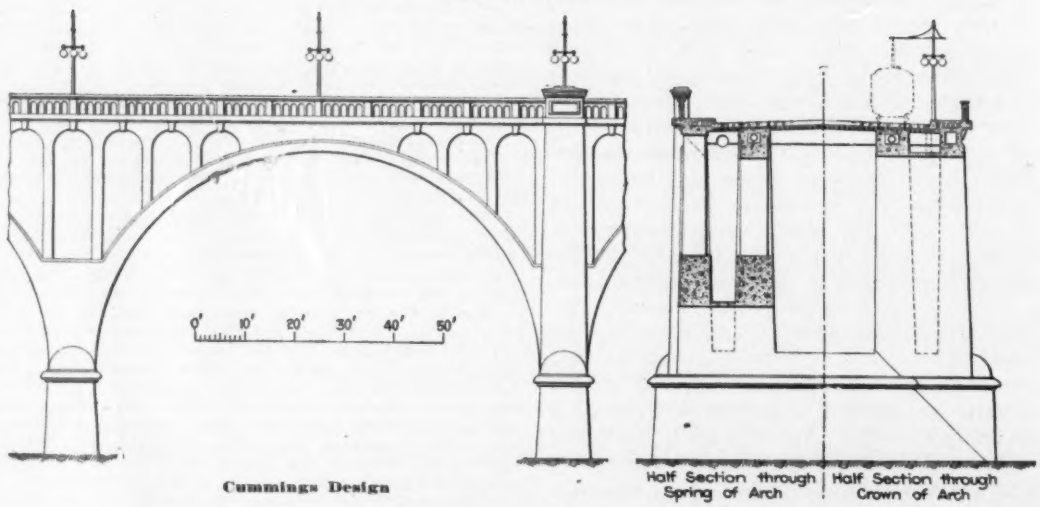
The æsthetic treatment is necessarily subordinate to structural efficiency. However, the nearer an harmonious combination of the two principles can be secured the more ideal will be the result.

In considering the æsthetic side of my design there has

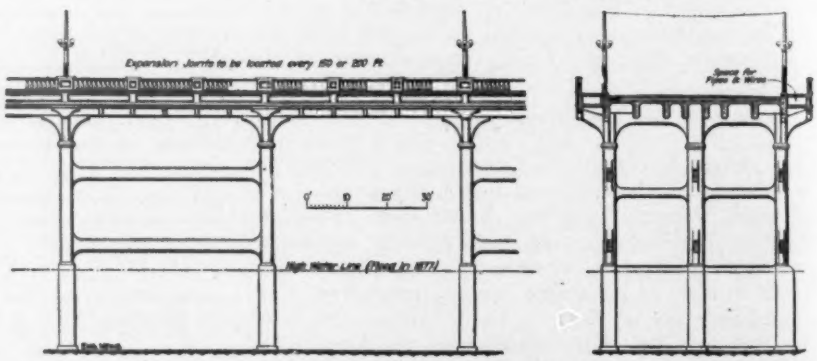


Davis Design

Section A-B



Cummings Design



Scarborough & Roelker Design

FIG. 2. DETAIL ELEVATIONS AND SECTIONS THROUGH ROADWAY, JAMES RIVER BRIDGE

been an effort to express the purpose of the bridge. This is partly emphasized in the grades of the roadway, which are carried level at a high elevation and above high water over the river crossing. The site of the bridge is across the rocky rapids of the James River just above the limit of tide and navigation. The river not being navigable here, it is obvious that long spans are useless and serve no economical or structural purpose. Hence, the present piers were utilized. Further, short spans were naturally suggested by the shallow and frequently bare river bed of rocky boulders and crags.

It is equally important to regard the bridge as a whole in which there shall be self-evident a symmetry of composition or of æsthetic "motifs" accentuating their uniformity of purpose. In this design there are three "motifs," the approaches, the river crossing and the intermediate section. The last "motif" was necessitated by the peculiar physical conditions and overhead crossing of the C. & O. R.R. which broke up the continuous uniform treatment between the two shore approaches.

The first "motif" is composed of the two land approaches consisting of the slab and girder floor system supported by columns on footings and concrete piles.

The second "motif" is composed of the river crossing and consists of semicircular arches supporting an open spandrel colonnade which carries the roadway and utilizes the old piers in the new masonry.

The third "motif" is composed of the intermediate section consisting of smaller span arches connecting the Richmond Approach with the center or second "motif."

Honorable Mention

There were only two money prizes awarded, but the Board of Engineers, who finally made the award, decided that the design submitted by J. C. Roelker and F. W. Scarborough, both of Richmond, Va., was deserving of honorable mention. This design, as noted at the bottom of Fig. 1, is radically different from either of the two premiated designs. In the first place, it does not follow the instructions of the requirements as to location, being moved one block away to the line of Tenth St. instead of Ninth St. In the second place, it is not an arch structure but of beam-and-girder type. It may be noted that the city of Richmond has already one of the heaviest reinforced-concrete beam-and-girder bridges, or viaducts, in the country, the one used by the Richmond & Chesapeake Bay Ry.

We give below extracts from the brief submitted by Messrs. Scarborough and Roelker in description and defense of their design:

After most careful consideration we arrived at the conclusion that it would be a serious error to have the approach to the bridge so situated that it would be necessary to cross the Chesapeake & Ohio R.R. yards at grade, also that Tenth St. is most favorably situated, all things considered, as the approach to the proposed bridge.

The following reasons have led up to this conclusion: Tenth St., at present, is a street of small traffic; it is blocked at Cary St. by the Chesapeake & Ohio R.R.; it is resumed at Byrd St., and stops again at the Race Canal.

Ninth St., even without the Free Bridge, is a thoroughfare connecting the main body of the town with the railroad yards of the Chesapeake & Ohio, the Richmond, Fredericksburg & Potomac R.R., and the Atlantic Coast Line, with all the industries on Tenth St., south of the Chesapeake & Ohio yards, the large industries on Ninth St. proper, and the valuable property on the island south of Race Canal.

Any construction that would interfere with the traffic on this street in any way, would cause serious damage. If this traffic over the Free Bridge was removed from Ninth St., it would still be a busy thoroughfare. Ninth St. is the only through street from Main St. to the river between Seventh and Twelfth Sts. The grades on Ninth St. are fairly easy. The grades on Seventh St. and Twelfth St. are very steep, and Twelfth St. is narrow and crooked.

The above reasons convince us that the best interests of the city are served if we let Ninth St. remain as it is, and build the approach to the Bridge between Richmond and South Richmond in Tenth St. The city would then not only lose nothing in traffic facilities, but if our plan be adopted, would be actually gaining a new street.

The practice in all thickly settled communities is to separate the traffic on the street from the traffic on the steam railroads. The danger and delays of a grade crossing are too well known to bear repetition. The bulk yards of the Chesapeake & Ohio east of Ninth St. are of mutual benefit to the merchants and manufacturers of the city, and to the Chesapeake & Ohio R.R. Very nearly every city in the United States is now suffering from cramped railroad facilities, and, in a number of cities manufacturers are removing their plants to beyond the city limits in order to get adequate railroad facilities. These cities, of course, lose the benefit of the taxes on the plant so moved and the revenue derived from the operatives. The design that we submit is made with a view to avoid such condition growing in Richmond on account of the delayed switching service in these yards.

The wear and tear of the equipment and tracks of a street railway, crossing from 12 to 14 tracks, is a considerable item. Steps are to be provided at Tenth and Byrd Sts. so that pedestrians having business south of the Chesapeake & Ohio yards will not be delayed by the switching.

Our design shows a simple reinforced-concrete viaduct, with spans of about 50 ft. in length over the river, and 35 to 55 ft. over the streets. This construction is continuous from end to end, there being no reason in our opinion to change the construction in the river bed. Our design gives sufficient vent area for the water, being more than given by the Atlantic Coast Line's viaduct and the Virginia Railway & Power Company's dam above.

With regard to accumulation of drift during freshets, we will say that our river spans of 50 ft. preclude the possibility of this accruing to a danger point, and that in the construction of this bridge, the Atlantic Coast Line thought it of so little consequence that they did not deem it of enough importance to remove the old piers which formerly carried their bridge, consequently we have not thought it advisable to change the construction over the river from that which of necessity must be used on land.

The adoption of handsome arches or trusses with curved chords would be very expensive, and, in our opinion, a waste of money. From no point in the city could such an ornamental bridge be seen to advantage. A bridge with a substantial roadway, pleasing to the eye, supported by a structure economically designed for strength and utility, is the one that would best serve the needs of the public. This bridge is hidden from sight from Gamble's Hill Park by the Atlantic Coast Line viaduct, and there is no other point from which it can be seen to advantage; the Atlantic Coast Line contemplates the disuse of Byrd St. as a passenger terminal.

There is no difficult construction on Tenth St., such as will have to be encountered on the lower end of Ninth St., where the grades separate one-half of the street leading to the island above mentioned, and one-half leading to the factories, Arch St., and to the present Free Bridge. The lower division of this street is so narrow that no obstruction should be placed therein.

The south terminus of our design at the end of the present Free Bridge was chosen for the following reasons:

(1) South Richmond is growing very fast to the westward, and this west end should have bridge facilities.

(2) The east end of South Richmond will be well served upon the completion of the Mayo Bridge.

(3) If an attempt should be made to turn this bridge further down the stream the property damage incurred to the Southern Ry. yards and shops would be enormous.

(4) The bridge shown on our plan can be constructed so as not to interfere with the traffic on the present Free Bridge until about two months before its completion, while if Ninth St. route is chosen, no traffic could cross the river at that point for at least one and probably two years.

The piers in the river are designed for economy in cost and in erection. Each pier consist of three pedestals, connected by a reinforced web 1 ft. 6 in. in thickness, thereby saving the expense of a solid pier. Inasmuch as these piers are shown above the highest water of 1877, the work of the superstructure will never be delayed by a rise in the river. The piers to be built ahead of the superstructure, the viaduct bents to be erected by an overhead traveler on the roadway level, and the forms and supports for the roadway to be carried by portable wooden trusses, resting on the piers. The spans in the river being uniform, they allow the use of the same trusses and forms for the entire river section. These trusses and forms can be moved ahead and placed for the spans in advance by the traveler aforesaid.

The estimated cost of structure, complete as per plans, but not including street railway track, is in round numbers $500,000.

No definite move has been made by the city authorities toward the construction of the bridge.

Corrugated-Iron Construction on the Sacramento Valley Irrigation Project

By Eugene C. Mills*

The Sacramento Valley Project is located in California, on the west side of the Sacramento River, in Glenn and Colusa counties. It extends in a north and south direction for about fifty miles and covers a large portion of the best land lying between the river and the foothills of this distance.

The water-supply for this project is derived from the Sacramento River, at a point about five miles above the town of Hamilton, Glenn County. A main canal runs

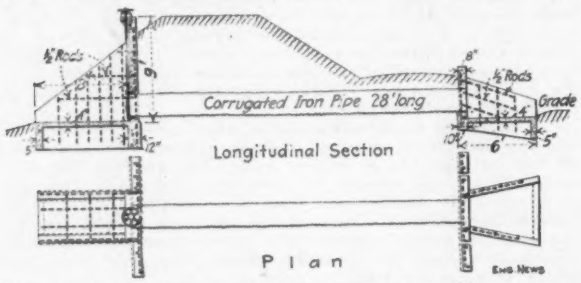


Fig. 1. Headgate for Laterals Taking Water from Main Irrigation Canal

from this point to about five miles south of the town of Maxwell, in Colusa County, a total distance of about fifty miles. From the main canal the water is distributed to the lands included in the project by means of branch canals and laterals.

The distribution of the water involved the building of a great many structures. Various materials were used for this purpose, including wood, concrete and corrugated iron, that material being used which was deemed best adapted to each particular structure. For the structures along the main canal and the more important branch canals, as well as the most important road crossings, only a permanent type of construction was considered, and the use of wooden structures was confined to drain culverts under the roads and small laterals and to a portion of the delivery gates and checks for the smaller ditches.

For permanent construction, the materials used were limited to concrete, either plain or reinforced, and corrugated iron, or to a combination of corrugated iron and concrete. The corrugated iron used was that known to the trade as American ingot iron, this having been chosen by reason of its exceptionally high purity. There seems to be no doubt that the principal cause of rusting in iron and steel is its content of substances of different electric potential, and in the case of this metal, the manufacturer's guaranteed analysis, the excellent coating of galvanizing which it carries and the condition of a large number of structures which have already seen quite a period of service were considered sufficient grounds for placing it in the same class with well built concrete in respect to lasting qualities.

Concrete, either plain or reinforced, because of its wide adaptability, was used in all classes of construction, but it was found that in certain types, especially in the smaller structures, corrugated iron could be used to greater advantage, and with a material saving in cost. The various installations for which this material was employed may be classified as follows:

1. Closed type of headgates in the main canal and in the principal branch canals.
2. Corrugated pipe for delivery boxes.
3. Lateral road crossings which were designed to carry the water underneath the road through inverted siphons, and so maintain a level crossing for the roadway. Also those lateral road crossings where the grade line of the lateral was maintained by corrugated pipe being used in place of a bridge.
4. Inverted siphons under the canals, to carry the natural drainage of the country across the line of the canal.
5. Inverted siphons for carrying irrigation water across the lines of natural drainage.
6. Road-drain structures, involving the use of corrugated pipe.
7. Sheet-iron flumes for carrying irrigation water across short depressions in the topography.

Corrugated-Pipe Headgate Construction

The headgates were classified broadly as open-type and closed-type structures, the open type being those for which the side walls rose above the top of the canal bank, permitting the use of a large cross-section for delivery of water. In the gates providing for smaller delivery it was found advisable to use a barrel type, provided with wing walls at both ends and a pressure gate for controlling the water. The larger structures of this type were built with a concrete barrel, but where they were not required to pass more than 30 to 40 sec.-ft. of water it was found to be much more economical to use a corrugated, galvanized-iron pipe barrel with concrete head walls and a cast-iron gate, the gate being raised and lowered by means of a hand wheel working on a threaded bolt which was attached to the upper side of the gate. This type involved considerably less excavation than would be required for a concrete structure of the same capacity; and while it is probable that the coefficient of friction of corrugated iron is somewhat greater than that of good concrete, yet, owing to the short length of pipe in use (varying from 20 to 50 ft., depending upon the height of the canal bank) this feature was considered negligible. The frame for the cast-iron gate was also cast iron, and was made with a collar at the back, 3 in. in depth, and of an inside diameter corresponding to the outside diameter of the corrugated pipe. This was provided with four holes for riveting the pipe to the collar. The gate frame having been riveted to the pipe, and the pipe being in place, the forms were then set for the headwalls, these being carried out to form retaining walls, and the concrete poured, the concrete when in place forming an absolutely water-tight joint between the gate frame and the pipe. These head walls were about 8 in. in thickness, and were lightly reinforced to give added strength against the pressure of the banks. The general design of these gates is as shown in Fig. 1.

Corrugated Pipe for Delivery Boxes

The normal farm unit varies in size from 10 to 40 acres, relatively few being less than 20 acres. The normal irrigating head for a 20-acre tract is assumed as 5 sec.-ft. continuous delivery for a period of 24 hr. For

*Chief Engineer, Sacramento Valley Irrigation Co., Willows, Calif.

tracts of less than 10 acres, the head is reduced proportionately. As much of the land lies very flat, and as the canal gradients are uniformly low, it was found generally necessary to carry the canals in fill in order to maintain water surfaces sufficiently high for proper delivery. As a consequence of this condition, it was necessary to keep the head at a minimum for most of the deliveries. For this purpose an open type of wood structure was used, the depth of water being from 1 to 1.2 ft. through the gate opening, the gate being provided with two openings of a net width of 2 ft. each.

It was desirable to keep the cost of the delivery boxes as low as possible, and for this reason corrugated iron was not considered for any case where it could not be installed for a price as low as, or lower than, the cost of the wooden structures. Where a sufficient delivery head was available to produce a proper velocity, a corrugated pipe could be installed, giving greater permanence of construction and equally as satisfactory operating conditions. Where the size of pipe did not exceed 18 in. in diameter it was found feasible to substitute corrugated iron for the open-type wood gate, the pipe being provided

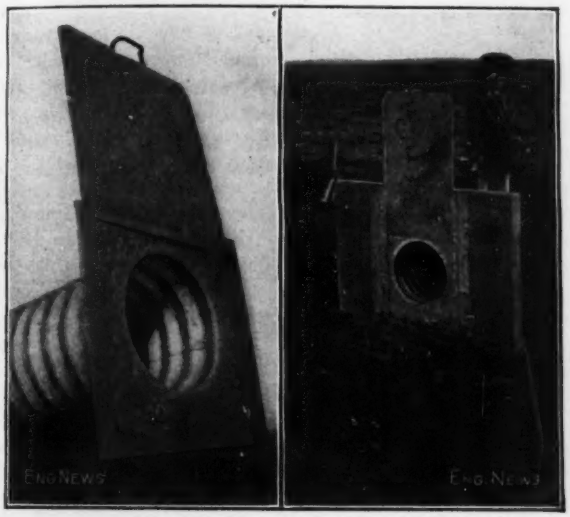


Fig. 2. Before Installation. Fig. 3. After Installation.
SHEET-METAL HEADGATE BEFORE AND AFTER INSTALLATION IN 4-IN. REINFORCED-CONCRETE HEADWALL OF DELIVERY BOX

with a sheet-metal slide gate, made by the pipe manufacturers, and shipped already attached (Figs. 2 and 3). Where openings were provided for the irrigation of areas of less than 10 acres, the quantity of water being materially less than the standard irrigating head of 5 sec.-ft., it was found feasible to use this type of construction quite freely, and if a larger fall in the water service had been available for the quantities delivered, so that a small diameter of pipe could have been used, the conditions would have been such as to warrant the almost universal adoption of this type for these situations.

LATERAL ROAD CROSSINGS

Where it was found necessary to carry the irrigation water across the main county highways, in order to avoid the inconvenience to the traveling public of numerous lateral bridges, it was decided to employ depressed crossings, and so maintain the natural level of the roadbed. The first structures of this type which we installed were entirely of concrete, consisting of a concrete barrel with wells and headwalls at both ends, the siphon being of such a clear width between headwalls that the roadbed would have a width of 24 ft. Where the quantity of water to be handled did not exceed 10 sec.-ft. it was later found that in many cases corrugated pipe could be substituted for the concrete barrel with a material saving. Here, as everywhere, the saving was both in money and in time.

On those roads which were not so frequently used, a cheaper type of lateral road crossing was adopted, in a majority of these cases the grade line of the lateral being maintained and a bridge installed for carrying the highway over the water channel. Where the quantity of water was not large, and a sufficient head was available, it was found to be cheaper, and to afford much more satisfactory crossings, to install corrugated pipe with its bottom a few inches below the bottom of the lateral, and to backfill between the lateral banks and over the top of the pipe, giving the pipe in any case not less than 1 ft. of covering. The width of the roadway at these crossings was not less than 16 ft., and it was found more satisfactory to extend the pipe sufficiently to pass beyond the natural slopes of the fill rather than to install either metal or concrete bulkheads. This type of crossing gave practically permanent construction, and entirely eliminated the jolts which are usually felt at the ends of a bridge after the approaches have settled. In operation, these crossings were entirely satisfactory and easily maintained in respect to freedom from weeds, and other obstructions. The canals are built with a freeboard of not less than 1 ft.; and the pipe was laid so that its top would come at, or only slightly above, the established running-water surface for the given lateral. The construction was completed by backfilling between the banks of the lateral over the pipe, and by carrying the slopes out to the roadbed on a 10% grade. By giving the pipe a slope sufficient to materially increase the velocity of the water through it, over that in the canal above, any silt which is brought into the pipe by the water of the canal will, by means of the greater velocity, be carried through without any possibility of settlement. In this case, as in that of the siphons, a capacity of 10 sec.-ft. was found to be the economical limit for this type of construction, comparisons being made on the basis of equal cost for a wooden bridge for the same lateral.

In all cases where the corrugated pipe was used to carry irrigation water under more than 2 ft. of head, it was found desirable to have it soldered by the manufacturer before shipment. Where it was found necessary to join together two or more lengths of soldered pipe in the field, in order to obtain a structure of the requisite length, the joints were also soldered in the field, as part of the work of installation. On the other hand, where the pipe was used under low irrigating heads and for drainage purposes only, the ordinary construction was found entirely satisfactory. A careful clinching up of the sections at the time of manufacture is essential to the use of corrugated pipe for irrigation purposes and enables the use of this pipe for low heads without soldering.

INVERTED SIPHONS FOR NATURAL DRAINAGE

This type of structure was used, particularly under our main canal. This canal runs parallel to the Sacramento River in a general way, and as a consequence

crosses the natural drainage from the foot-hill country toward the river. It was, of course, necessary either to carry the drainage under the canal, or the canal under the drainage of Willow Creek. With two or three other exceptions, it was found feasible to carry the drainage under the main canal. As the branch canals follow the general slope of the country, there are no large drainage crossings, and it was found possible, in nearly every case, to carry the drainage under the canals.

For drainage siphons, either concrete or corrugated iron has been used, the conduit consisting either of a reinforced-concrete barrel (or, in some cases plain concrete sectional pipe) with concrete wells and head walls at each end, or of corrugated pipe of the proper diameter, with concrete wells and head walls. Where the drainage to be cared for was not large and concrete pipe was not conveniently available, corrugated iron was employed.

Later experience has shown that the use of concrete pipe for this work is not satisfactory. It has been found that in ground naturally softened with drainage water, or which became softened by the seepage of the canal, the concrete pipe settles and in settling breaks open at the joints. This permits the seepage from the canal entering the pipe, resulting in the development of open channels between the bottom of the canal and the broken

FIG. 4. A 54-IN. CORRUGATED-IRON FLUME CARRYING IRRIGATION CANAL ACROSS A NARROW DEPRESSION

pipe joints, with a consequent waste of the canal water. This was sufficiently grave in some cases to warrant the removal of the concrete pipe and its replacement by corrugated iron.

INVERTED SIPHONS FOR CARRYING IRRIGATION WATER ACROSS NATURAL DRAINAGE LINES

Through certain portions of the project, in times of very heavy rainfall, the runoff is excessive. If the natural outlets of the country were blocked by lateral banks, it would result in impounding the water and doing injury to various property holders. Under these conditions, it has been advisable in certain cases to omit the lateral construction for the space of from one to three hundred feet and to carry the irrigation water across these broad and shallow natural drainage ways by means of an inverted siphon, laid under the drainage, the top of the pipe being about 18 in. below the natural ground surface.

If the jobs had been larger, concrete pipe could have been installed at a less cost, but for small jobs, such as those indicated, it would be out of the question to establish a pipe yard for the construction of concrete pipe, and the nearest pipe yard in operation was so far away that hauling pipe from that point to the point of our installation was out of the question. In order that this construction might be both permanent in its character and economical as to cost it was found advisable to make use of corrugated pipe.

ROAD-DRAINAGE STRUCTURES

While we fully realize the value of corrugated pipe for road-drain crossings we have adopted a more temporary type for the smaller drainage areas, and have installed wooden boxes. In the broad, natural drainage ways a bridge was the only type which would meet the conditions. There were, however, a number of artificial drains which were constructed with an average depth of 6 ft. and with a base width of 4 ft., the side slopes being 1 to 1. At many of these crossings 72-in. corrugated pipe was employed. This use of the material is, of course, that for which it was first designed, and its success in this capacity probably needs no further comment.

SHEET-IRON FLUMES

In some cases it was necessary to carry the canals across narrow and deep natural drainage areas; and for this purpose a corrugated flume was used. These installations being short, the element of friction loss was considered negligible, although had flumes of considerable length been necessary there is no doubt that smooth construction would have been adopted. Fig. 4 shows a typical installation of this sort.

The advisability of the employment of corrugated iron for purposes similar to those here described is dependent upon the character of the construction almost as much as upon the grade of the material itself. Hasty and careless work at the pipe factory may involve results which will nullify all the benefits to be derived from a durable metal. The rivets should be of sufficient size and number and, where possible, of the same metal as the remainder of the pipe. Thorough and accurate work in cinching up the sections before riveting makes a decided difference in the strength and serviceability of the conduit. With this material, as with many others, when used in construction of a permanent character, it is economical to pay a price which constitutes a reasonable premium for intelligent work and high standards of commercial policy.

The Publicity Work of the Cleveland Engineering Society

BY C. E. DRAYER*

Several members of the Cleveland Engineering Society were discussing informally the Society's affairs a year or so ago when one of the officers said that while the newspapers were giving large space to the news of various other organizations of the city, the Engineering Society, whose members are responsible in a large measure for the growth and progress of Cleveland, was receiving practically no mention. The writer replied that to his personal knowledge this condition was due to the fact that the organizations referred to had a regular channel through which information was furnished the papers, and he expressed the opinion that the same means would secure

*Chairman Publicity Committee, Cleveland Engineering Society, 1801 East 93d St., Cleveland, Ohio.

attention to the Engineering Society. In a few days he was asked by the President of the Society to take up the publicity work.

The first step was to see the Managing Editors of the two morning papers. They were handed directories of the Society and were told that it had nearly 500 members, many of whom were at the head of large undertakings on which the growth and prosperity of the city depends. They were also told that the Society stood ready to coöperate and help them to obtain such engineering news as would be of interest to the community. One of these editors expressed the opinion that one reason why news of an engineering nature does not get into the daily papers is because the ordinary reporter has not the technical knowledge to properly handle it. He suggested that the Society should be its own reporter.

The issue of the Society's *Journal,* which was then ready for distribution, contained the report of a special committee on Technical Education in Cleveland. Naturally, a large number of people in the city are interested in what engineers have to say about their technical schools. Two abstracts of the report, ready to print, were handed to the editors of the morning papers. They were accepted without alteration and each occupied about two-thirds of a column. The report handed to another paper called forth a double-column editorial 13 in. long. Without the assistance of the newspapers, the findings of the committee would have appeared only in the 1500 copies of the *Journal* to be read by about that many technical men. In the newspapers the abstracts appeared in over 200,000 copies to be read by as many in the community as were interested.

An associate editor, a veteran in newspaper work, said in a talk before the Society:

> Science, a little obtuse at times, will learn that newspapers are not entirely devoted to baseball and casualties, to politics and gossip. The newspaper reaches out in countless directions. It wants the best that is available and it wants it in prodigous variety. It stretches a warm hand to science. It realizes that the annals of invention and technical achievement put romance to shame. It knows that the soldiers of science, bridge spinners, canal diggers, are the dauntless skirmish line of advancing civilization. The newspaper stretches a hand for your copy, assuring you that the public is interested in your proceedings because they advance public welfare. The newspaper offers you space in its columns, leaving to your judgment the selection of matter best calculated to interest the lay reader. It asks you to refrain from puzzling technicalities and as far as possible to cover a variety of the themes that should make a popular appeal.

A Chicago man once intimated that the opportunity for engineering publicity existing in Cleveland is unique. If there is any secret to impart to him, it is this: furnish good copy on timely subjects ready to set in type. The following is an illustration of timely copy:

The foundations of a great high-level bridge, the main artery between the parts of the city on either side of the Cuyahoga Valley, are now being laid. Late last year a lively controversy arose as to the safety of these foundations. The public has a right to be fully informed about any undertaking in which it is so vitally interested. Much space in the daily papers was given to the opinion of various civic bodies and public-spirited citizens, many of whom spoke without being fully informed. The question was whether the bridge would be in danger if its foundations rested on hard clay, as called for in the plans, or whether caissons should be sunk at a large additional cost many feet to bedrock.

In December the County Bridge Engineer, who had in charge the making of the foundation plans, was asked by the Cleveland Engineering Society to read a paper at one of its meetings on "The Foundations of the High Level Bridge." His paper was abstracted with the technicalities omitted or so worded as to be understood by the lay reader of average education. When the abstract appeared in one of the papers on the Sunday following the meeting, correct and dependable information on the high-level bridge for the first time became available to the public.

Perhaps the following instance will illustrate the editor's statement above that the ordinary reporter is not equipped to handle the proceedings of a technical society. It also shows the effort the newspapers make to get engineering news.

On Nov. 25, an illustrated paper was read before the Society on "The Use of Electricity in Coal Mines," with special references to haulage and cutting problems. The author of the paper is directly connected with the development of a machine for mining coal without the use of powder. Any engineer can appreciate the possibilities of this subject for a newspaper story. The meeting was duly announced in the papers and a reporter came to the meeting, but he soon left. At the door he met a reporter from the other morning paper. "What's going on?" was the query of the latter to the one coming out. "I can't get anything, it's too much for me," was the reply. 'Let's go," said the man who had not been in at all. Naturally nothing appeared in the papers next morning about that meeting. But we can write a 1000-word abstract of the paper on "The Use of Electricity in Coal Mines" and the newspapers will be glad to print it.

The experience of over a year in this publicity work justifies the statement that more frequent appearance of engineers before the public, both personally and in writing, will result in mutual benefit to the engineering profession and to the public.

Tangible results in the growth of the Society, both in membership and in interest due to the publicity work, are not lacking. It is the custom of the publicity committee to give to the newspapers, for use on the morning preceding the semi-monthly meetings, a picture of the speaker together with some 150 words of descriptive matter giving a little of the speaker's history and a few hints as to the way he will treat the subject. The Assistant Secretary of the Society says these notices have increased the attendance at the meetings during the past year about 15%. Formal notices of meetings sent to the members a few days in advance do not make the same impression as the notice in a newspaper. Especially if the speaker is from out of town and not generally known to the membership of the Society, an effect, easily felt but hard to describe, a semi-acquaintance as it were, is produced by seeing the speaker's picture and learning something about him.

Last year 110 members were added to the roll of the Society. The chairman of the membership committee stated that the publicity which the society was receiving made it easier to present the advantages of membership to anyone eligible. The chairman of the program committee attributes a part of the live interest in the meetings to the same source.

Amount of Publicity Work Done—Previous to June 30 of this year about 1000 single-column inches appeared in eight papers, mostly in Cleveland. Since June

30, there have appeared about 1500 single-column inches in twelve publications, both local and national in circulation. 1500 inches would make about nine pages of the ordinary newspaper.

Early in the present year there were published in one of the Cleveland evening papers, letters from young men asking the editor what education is required and what are the opportunities for success in civil and mechanical engineering. The editor discreetly printed below the letters a request that engineers of each of these branches answer the young men's questions. Last spring the principal of one of Cleveland's large high schools asked a member of the society to come to the school and tell the boys what the profession of engineering is and what qualifications and predilections should be possessed by a candidate. The principal said a number of his pupils intended to study engineering and that he felt their understanding of what was before them was vague and inaccurate.

Here was an opportunity for the publicity committee. It accordingly asked the President of the Society, a civil engineeer, to write an article explaining for the benefit of the young man about to choose his life work what is before him in the engineering profession. The editor to whom the paper was handed liked the idea so much that he asked for a second article to cover the field of the mechanical engineer. After the second article was published, he asked for a series of articles on the above theme by engineers practicing in the various branches of the profession. This series began about the middle of September and was concluded about the middle of December. The quality of English in these articles refutes the criticism frequently heard that engineers lack the ability to express their thoughts in clear and pleasing form. Analysis of poorly written articles by engineers or others will generally lead to the conclusion that hazy writing is merely the result of hazy thinking.

After arrangements were completed with the several men to contribute, a list of subjects and authors was submitted to a New York publishing house which expressed a desire to examine the papers with a view of putting them in book form. It was rather an easy and pleasant task to persuade these busy engineers to write, although writing articles in a popular style is not a part of their customary occupation. Their willing response to the request for articles is an indication of the favor with which the leading engineers of the city view the publicity work of the society.

Problems Found in Publicity Work—Our ideals are not reached by the newspapers, yet we are cautious about telling this to the editor. Rather we try to appreciate his problems and get his view point. "I can no more keep the news as it comes from passing through its natural channel, this paper," said one, "than I could stop a river by building a dam." Our copy is passed upon according to its merit measured by newspaper standards. It must have news value and a style not too distinct from the paper in which it appears, yet always dignified, always authentic, and not overcharged with enthusiasm. Once in a while it will happen that copy representing a certain amount of valuable time and energy is cut down or lost entirely because something of greater newspaper value presses for space. To become disgruntled at this is but to confess that one has not been around newspaper offices enough to learn what a mighty task it is to get out a great city daily.

A man, who is principally a politician but also successful in business, recently said before the Society that one's heart is put into his work only when it yields personal glory or pecuniary reward. He possibly forgot love of the work itself and love for a cause. The man who supplies news from an engineering society must find his inspiration in the motives which the politician forgot to mention. His reward must be in the realization that for the public he is a standard bearer of enlightenment, and for the the engineering profession he strengthens its ranks and advances its position in the estimate of the community. He must contribute from his leisure time. He cannot expect to use the time when his mind should be at work on his business or that of his employer. Like the products of work in any field, results are in direct proportion to effort.

A principle of publicity and education is that the germs of ideas are planted in the minds of men to take root and grow when conditions become favorable. The financial editor of one of our papers came to us recently for information to be used in a feature article which he wanted to write about engineers. He was asked how he happened to have engineers uppermost in his mind. He replied that he saw in the daily papers that the Cleveland society went to visit the Pittsburgh engineers and that he had seen the series on "Engineering as a Life Work" described above. His article in the paper on the following Sunday was headlined "Engineers Are the Men Who Make Dreams Real—Solve the Problems that Confront Factory Owners, Railroads, Governments, on Water and on Land and Underneath." It is probable that some readers will consciously, some unconsciously, have an increased estimate of the engineering profession from reading such statements.

The writer is assisted in the publicity work of the society by the Professor of Mechanical Engineering of Case School of Applied Science and by one of the leading architects of Cleveland. Mention is made of the personnel of the committee as an indication additional to that cited above of the attitude toward publicity work by men at the head of the profession in the city.

It may be of interest to recall here the unique origin of the Cleveland Engineering Society.

A society was formed in Cleveland 33 years ago under the leadership of the late Charles Latimer, with the object of studying the Great Pyramid and combating the introduction of the metric system. Several of the younger engineers who received invitations to join, declined. They felt that many modern problems were more important to them than the dimensions of the Great Pyramid, which could be intrusted for solution to the archæologist. As for the metric system, instead of opposing it they set to work to find how many local engineers would advocate its introduction. Inquiry into the number in the city inspired them to organize a permanent engineering society.

Founded in the spirit of progress, the Cleveland Engineering Society has ever maintained high professional ideals under capable leadership. Among its past presidents are General John M. Wilson, Chief of Engineers. U. S. Army, Retired, General Jared A. Smith, A. M. Wellington, Ambrose Swasey, S. T. Wellman and Worcester R. Warner, the last three past-presidents of the American Society of Mechanical Engineers, Dr. Charles S. Howe, president of Case School of Applied Science, Dr. Dayton C. Miller and Dr. Chas. H. Benjamin. The

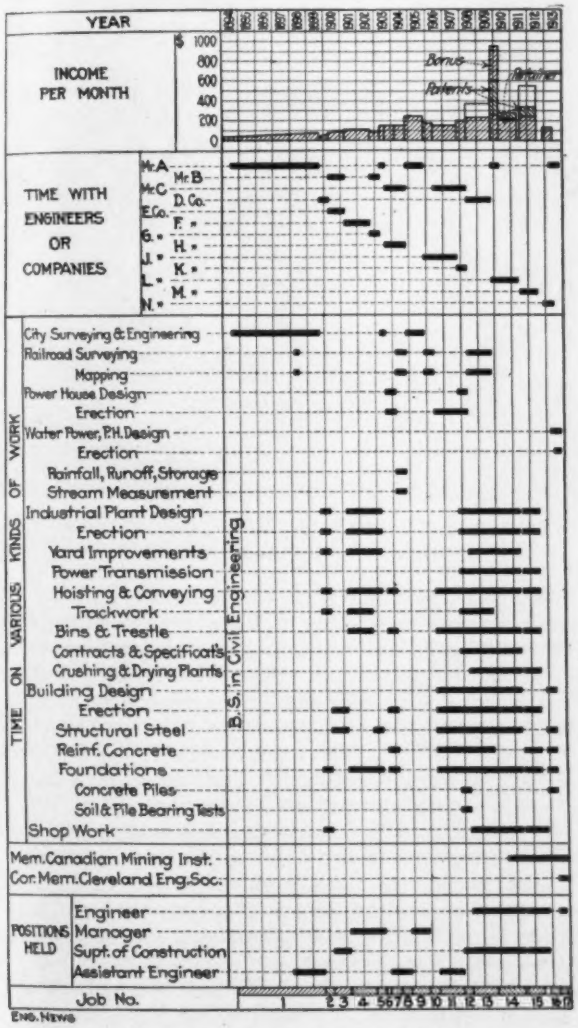
society has now a membership of about 600 and is housed in the Chamber of Commerce Building.

In conclusion, the purpose of this article has been to show what has been actually accomplished by one engineering society with the hope that others may engage in it. Conditions in Cleveland may be somewhat different from those in other cities; but they are not so unique or unusual but that it is safe to say similar results may be produced with like effort anywhere.

A Professional Experience Chart

An engineer in search of a position applied to the head of a well known engineering concern and was advised to make a record of his professional experience and submit it for consideration. Shortly afterward there was received from the applicant in reply two charts, in the form of whiteprints, of standard letter-sheet size, with neat lettering. The charts are reproduced herewith.

Many will claim that the engineer who presented his professional record in this unique way was one of the fellows with a mania for system and efficiency, but poor on executive work. Whether that was so or not we are not informed; but he landed the job.



A Chart and a Record of an Engineer's Professional Experience

Improvements effecting notable savings in operating or first cost. The items 1-20 indicate work of entirely original character. Figures in circles refer to job numbers on chart.

———"———

Item
1 Disintegrator (patented) 6 on (13), 6 on (14).
Capacity, each, 20 tons per hr.
2 Improved disintegrator (patented), 2 on (15).
Capacity, each, 80 tons per hr.
3 Separator (patented), 5 on (15).
4 Exhaust system (air) (14).
5 Exhaust hood (14), (15).
6 Graders, 8 on (14), 6 on (15).
7 Flow sheet (13), (14), (15).
8 Alteration in ore dryers (14).
9 Screen frame (13), (14).
10 Retaining wall (13).
11 Ore bin (13), (14).
12 Cableway hoist carriage, 10 on (14), 4 on (15).
13 Shop hoist (12).
14 Automatic bucket dump (4).
15 Erection derrick (3).
16 Vertical beam storage (5).
17 Reinforced concrete stair horse (11).
18 Card system for field notes (9).
19 Card system for tests (14).
20 Arc light suspension, wiring system (14).
21 Standardized transmission equipment (15).
22 Temporary intake screens (11).
23 Brass foundry (12).
24 Yard layout (4), (5).
25 Changes in building and trestle (12).
26 Method of hoisting (3).
27 Method of handling yard force (4).

Excerpts from unsolicited letters. "Mr. A.", "L. Co.," etc., refer to chart.

———"———

Mr. A.—"He is a man who can be thoroughly recommended in every way."

Mr. C.—"A man in whom I have entire confidence . . . who is not an experiment, but who has made good on previous occasions."

Consulting Manager, K. Co.—"I again extend to you my thanks for the very satisfactory manner in which you performed your work while on the job."

President, L. Co.—"I wish to congratulate you on the result of your labors in connection with our mill. I appreciate very much indeed the work that you have done . . . . as a slight token of my appreciation . . . I enclose you a check for one thousand dollars."

Vice President, L. Co.—"While I had every confidence in your carrying out your plans successfully, I fully expected some vexatious delays before they could be perfected; and it is both a surprise and pleasure to me to find that you have not only made good in your designs, but that you have succeeded in completing the mill in such a short time."

Newspaper Clipping.—Job (14)—"The mill which was designed by . . . . . contains several new features . . . its completion during the winter months has been a surprise to everyone, as it was freely predicted that it would be impossible to have the mill in operation on May 1."

The Corps of Civil Engineers, U. S. Navy, has always suffered from the slow promotion of its members, but as long as it was recruited from the civilian graduates of technical schools, the comparison between their rank and the rank of the graduates of the U. S. Naval Academy in other branches of the service was not so marked as it is now that Naval Academy graduates are being drawn upon exclusively for the Corps. The recent annual report of Rear Admiral Stanford, Chief of the Bureau of Yards and Docks, very pertinently calls the attention of the Secretary of the Navy, and incidentally of Congress, to this highly unjust condition of affairs. The report, in part, says:

Attention is invited to the unfortunate condition of the assistant civil engineers of the Navy as regards their rank, and as a consequence, their pay. The act of Mar. 3, 1909, provided for 12 assistant civil engineers, 6 with the rank of lieutenant, junior grade, and 6 with the rank of ensign. Increased rank can only come by promotion to the full grade of civil engineer as vacancies occur in that grade.

Of the last 18 assistant civil engineers, 13 were appointed from the Naval Academy. Graduates of the Naval Academy detailed to this corps are selected after one to two years' sea service, and are commissioned after a two years' course of study at a technical school. Such men, therefore, receive their commissions as assistant civil engineers with the rank of ensign three to four years after graduation, at a time when their classmates in the line have been promoted to lieutenant, junior grade, the law providing that ensigns in the line shall be promoted to junior lieutenant after three years' service as ensigns. Not only does the assistant civil engineer start out with lower rank than his classmates, but he retains this rank irrespective of the subsequent promotion of classmates of the same standing in the line (Corps of Naval Constructors). In the latter corps the assistants are appointed with rank of junior lieutenant and are promoted subsequently with their running mate in the line. The assistant civil engineer is not promoted in this manner until after he reaches the full grade in the Corps of Civil Engineers.

The injustice and hardship which the assistant civil engineers have to undergo as compared with their brother officers is well illustrated by an average case, a graduate from the class of 1908. He was commissioned an assistant civil engineer with rank of ensign June, 1911, and under normal conditions will retain the rank of ensign until 1920. This officer will be passed in rank by every officer in the active list below him today. Further, every graduate of the classes of 1914, 1915 and 1916 now at the Naval Academy will pass him. Not only these, but every individual making up the classes of 1917, 1918 and 1919 will be appointed, complete their four years' course, will graduate, and will rank with this officer, who will have served 16 years in the Navy. His running mate in the line was commissioned lieutenant, junior grade, in June, 1913. The case of those assistants appointed from civil life is even more disheartening as these officers when appointed were considerably older than officers appointed from graduates of the Naval Academy.

The bureau believes that it is imperative to provide immediate relief for these officers, not only in justice to the officers, but also to promote the efficiency of the corps and for the general good of the service. It is urged that the provisions of the law be amended to provide for the promotion of assistant civil engineers with their running mates in the line.

An Instrument for Solving Spherical Triangles Mechanically

The accompanying illustrations show a mathematical instrument, now on the market, which solves mechanically by the setting off of angles on rotating arcs, all the problems in spherical trigonometry which arise in navigation. It is called the "Mechanical Navigator." By manipulating this instrument a navigator may find in one operation a ship's place at sea from two sights, making allowance for the ship's run. This is equivalent to solving three astronomical triangles simultaneously, thus avoiding the use of the method of the Sumner lines or their treatment by the method of Marcq Saint-Hilaire. The result thus found mechanically is claimed to be within 2′ of arc, or less than the theoretical errors by the method of Sumner lines or Saint-Hilaire. The mechanical navigator may also be used to solve any other of the usual problems of navigation.

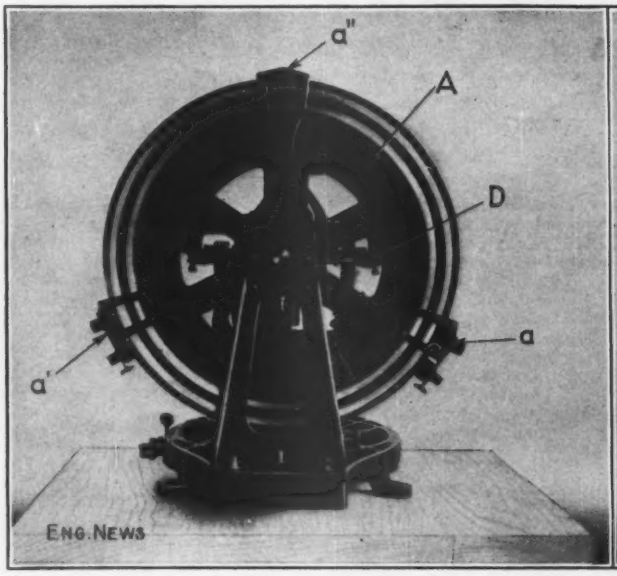


FIG. 1. SIDE VIEW OF THE "MECHANICAL NAVIGATOR," SHOWING EQUATOR CIRCLE

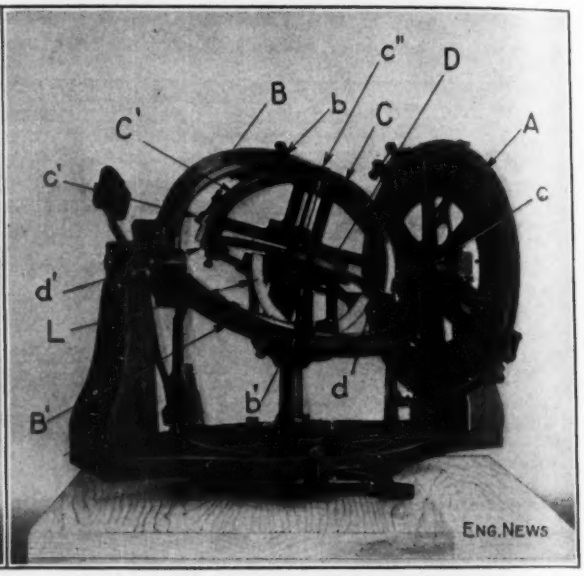


FIG. 2. THE "MECHANICAL NAVIGATOR," MADE BY F. E. BRANDIS SONS & CO., BROOKLYN, N. Y.

Although the mechanical navigator would probably prove of little value to surveyors, since it does not give results accurate enough for geodetic purposes, a brief description of it will perhaps be interesting; and an understanding of its principles and operation will help greatly to a thorough understanding of the problems of spherical trigonometry and practical astronomy. For this reason the mechanical navigator might easily be used in our technical schools to the advantage of the student.

The instrument is a mechanical representation of the celestial sphere. Letters are engraved on its various plates and circles and are shown in Figs. 1 and 2. Fig. 3 shows the outlines of the spherical elements only. The disk *A*, 12 in. in diameter, represents the celestial equator, which for mechanical reasons is placed at the north extremity of the fixed horizontal axis of the instrument. *A* carries two circles graduated on silver, one graduated in time (hours) marked with Roman numerals from O westward to XXIV, and with arabic numerals (for measuring right ascension) from 0 eastward to 24. The other circle is graduated in degrees to express longitude, 0° to 180° westward, and 0° to 180° eastward.

The vernier *a"* marks the meridian of the instrument. The graduated circles *B* and *B'*, 14 in. in diameter, represent hour circles, which are, of course, in planes perpendicular to the plane of the equator, and which move separately on the axis through the poles. The verniers *a* and *a'* on the graduated disk *A* are attached to these hour circles *B* and *B'*, respectively, and measure the angle settings of the hour circles for longitude or right ascension, as the case may be. The markers with attached verniers *b* and *b'* are used to lay off the declination of a heavenly body upon the hour circles *B* and *B'*. The center of one of the knobs of *b* fixes the position of the star, or other heavenly body. This center is 30° distant from the 0° of the attached vernier, which is used only to set to the minute reading.

The graduated circle *D* (about 8 in. in diam.) represents the horizon and may be tilted at any angle on a horizontal axis through the mathematical center of the instrument at right angles to the axis through the poles. When upright, i.e., horizontal, its position corresponds to a point on the equator. The angle between the planes of the horizon and the equator, which, of course, is the angle of latitude, is measured on the vertical arc *L* below the circle *D*. The arcs or vanes, *C* and *C'* (about 8½ in. in diam.) represent vertical circles, revolving on an axis perpendicular to the horizon through the zenith. The central part of the instrument, including *D*, *C* and *C'* is termed the "alidade" for convenience in reference.

The markers *C* and *C'*, with attached verniers, are used to represent the altitude of a heavenly body on the vanes *C* and *C'*. The center of the lower stop of the markers *c* and *c'* is oposite the 0° of the vernier, but the center of the upper stop, which is used only in certain problems, is 12° distant from the 0° of the vernier. The verniers *d* and *d'* are attached to the vanes *C* and *C'*, but travel and are read on the circle of the horizon *D*, and measure azimuth.

The marker c'' runs on either of the vanes C or C' and is used in laying off great circle courses when the arc is greater than can be measured on either one of the vanes, i.e., 90°. The 0° of the vernier is 45° distant from the center of the stops representing the position of the heavenly body, at either end of the marker. The marker c'' may also be used in special problems where it is necessary to lay off zenith distances greater than 90°. A spherical compass f (not shown) is used for representing the first zenith distance in those problems of double altitudes where one of the vanes C or C' must be used to represent the ship's run. The whole instrument is mounted on a vertical axis and can be turned in any direction convenient to the operator.

The foregoing description makes clear the principles of the instrument. A brief outline of operations for the solution of one or two typical problems will make the manipulation clear. Perhaps one with which engineers are most familiar is a single observation of the sun for time or longitude and azimuth. In this problem we have given at sea the Greenwich mean time of observation, from the ship's chronometer; the declination of the sun from a solar ephemeris; the altitude of the sun, measured by a sextant; the approximate latitude of the ship, by dead reckoning. To find the ship's longitude proceed as follows:

(1) Tilt the alidade, i.e., the circle D to the assumed latitude, measured on L, and clamp L in position.

(2) On one of the vanes C or C' clamp the marker c or c' at the measured altitude of the sun (corrected for index error of sextant, refraction, semi-diameter, etc.). The vanes C and C' (one of which is used) must remain unclamped in azimuth.

(3) Upon one of the hour circles B or B' set one of the knobs of the marker b to read the sun's declination at the time of the observation, and clamp marker b.

(4) Change the Greenwich mean time of observation to Greenwich apparent time by applying the equation of time. Set off this time on the graduated circle of the disk A by clamping one of the vernier a or a' at the correct reading; the hour circle B or B' is now clamped to the disk A and rotates with it about the axis through the poles. The disk A is left unclamped so as to rotate freely in either direction, moving the hour circle B or B' with it.

(5) The knob of marker b on the hour circle B (which it is assumed is the one used) and the stop of marker c on the vertical circle C are now brought into coincidence by making use of the two free movements; of the vane C in azimuth, and of the hour circle B and the disk A in right ascension. When b and c are in coincidence, the instrument is lightly clamped.

(6) The vernier a'' now gives the ship's longitude.

(7) The azimuth of the sun at the time of observation may be found at the foot of the front face of the vane C, the vernier giving the exact reading.

(8) Local apparent time (civil) may be found by omitting operation (4) and clamping the disk A to read XII hours at vernier a''; then the vernier a will give local apparent time. Or the local apparent time may be found by subtracting the longitude found above from Greenwich apparent time.

The operation of determining latitude, having an assumed longitude based on dead reckoning, is practically the reverse of the foregoing, the final setting giving latitude and azimuth.

The two vanes C and C' are used in the solution of the problem of determining a ship's position from simultaneous star sights, thus solving two spherical triangles at the same time. In this problem we have given Greenwich mean time of observation, from the ship's chronometer; the right ascension and declination of each star, from an ephemeris; the altitude of each star, measured by sextant. The latitude and longitude are determined by using one vane C and one hour circle B for the position of each star and with the three free motions of the instrument (1) the movement of the horizon D north or south, (2) the vanes C and C' in azimuth, (3) the disk A with the hour circles B and B' in time, bring the knobs b and b' into coincidence with c and c'. If the verniers a'', a' or a conflict, a way is provided of solving the problem by temporarily releasing some of the clamps.

The mechanical navigator is claimed to make a theoretically perfect solution of the problem of determining latitude from two solar observations at equal altitudes, allowing for the ship's run between observations. This problem requires the use of a spherical compass attachment f (which is really a supplementary 90° vertical circle) to set off the first zenith distance, as one of the vanes C must be used to represent the ship's run between sights. To determine latitude by equal altitudes from the same station the problem is much simpler and its solution apparent.

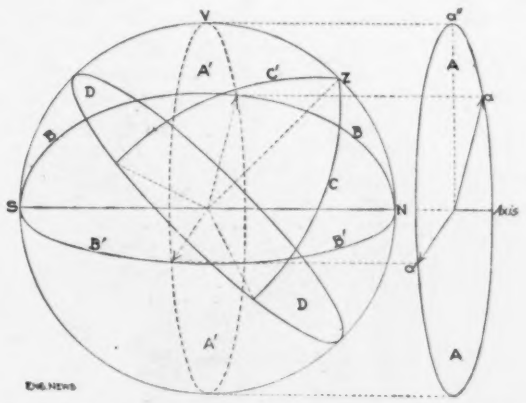


FIG. 3. ASTRONOMICAL ELEMENTS OF THE "MECHANICAL NAVIGATOR"

Besides the solution of all the other specific problems in navigation, which are not of particular interest to engineers, the instrument may be used to an advantage to identify stars, when sights are made on partly cloudy nights. In this case the alidade is tilted to the approximate latitude, the disk A clamped with vernier a'' reading the local sideral time, and one of the vanes C clamped on the approximate bearing or azimuth of the star observed. One of the hour circles B is then swung until the markers b and c coincide, when the approximate right ascension of the star may be read on vernier a and the approximate declination on the circle B, vernier b. The more important stars are on the disk A, the others may be identified by reference to an ephemeris.

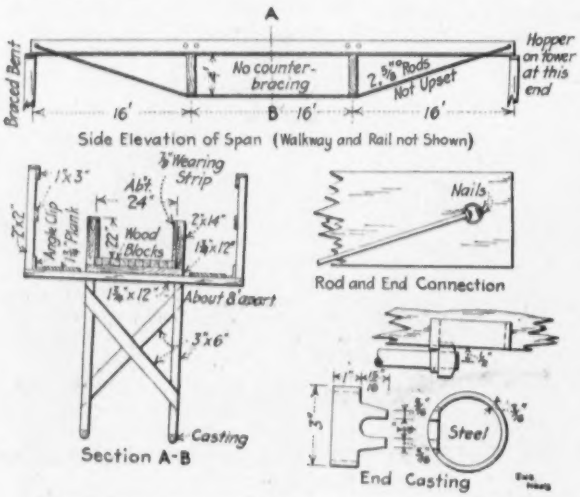
The "Mechanical Navigator" is made by F. E. Brandis Sons & Co., makers of mathematical and surveying instruments, Brooklyn, N. Y., and costs $2400.

Field and Office

Making a Fill by Sluicing through a Flume; Failure of Flume

By Henry Blood*

A structural plant is being built on the bank of the Willamette River in Portland, on a plot fronting some 300 ft. on the river and about 1000 ft. deep. Most of the ground is low, about 12 ft. above low-water line, and it has to be filled to El. 280. The company planned to make the fill by hydraulic dredging, but a dredge could not be obtained, and therefore the work was let to a contracting firm that has been doing waterfront fill work for several years.



Sketches Showing Construction of Gravel Chuting Flume.
(Approximate)

The contractor's method is to dredge gravel from various points in the river, bring it to the dock at the front of the lot, hoist it to a hopper built on a wooden tower on the dock, pump water into the hopper, and sluice the material to different parts of the property.

The top of the hopper is about 40 ft. above the dock. The wooden flume, made in sections 16 ft. long, is about 2 ft. wide and 1 ft. deep in the clear. Bents were set 48 ft. apart and the sections trussed together in groups of three, with two ⅝-in. round rods, not upset. Pieces of 3x6, about 4 ft. long, were used for struts, and the ends of rods held by a ⅞-in. steel casting 3 in. in diameter and 1 in. wide, set in a socket in the side of the trough. The bottom of the flume was lined with wood blocks on end. There was a walkway along each side for the use of workmen, and a light rail. The construction is shown (approximately) by the sketch.

Soon after beginning operations, on Dec. 29, the flume choked up between the hopper and first bent. While a workman was trying to clear it, the section collapsed. The end next to the first bent turned over endwise onto the middle piece. The man was thrown to one side and severely but not fatally injured. An examination of the wrecked portion a couple of hours after the accident indicated that one or more of the end castings had pulled from their sockets. The wreck had been somewhat disturbed, and it was necessary to obtain information from the foreman on the dock. The center panel had no regular counterbracing, although there were pieces of 1x6 nailed on the vertical struts and center trough, which are not shown on the plan. It is possible that this omission may have caused the failure, as the load was unsymmetrical after the flume choked.

A few calculations show that the construction is deficient: weight per lin.ft. of flume, etc., equals 65 lb. Weight of 2 cu.ft. water mixed with gravel at least 125 lb., perhaps more. Total load 190 lb. per lin.ft. Stress in each rod 5700 lb., or 28,000 lb. per sq.in. of section at root of threads. Bearing of casting against wood, 1880 lb. per sq.in. Moment tending to twist it out of the socket at least 5700 in.-lb., probably more. Lifting force at outer edge 5700 ÷ 3, or 1900 lb. A couple of small nails driven into the plank and clinched over top formed the only provision to resist the tendency to twist out. The stress in the lugs holding the ends of the rods approaches the ultimate strength of the metal, unless the bearing came on inner edge of nut. Other details (not mentioned) did not appear very secure, but none showed signs of failure.

The contractors seem anxious to make the structure safe, and are now placing well braced bents under the ends of every section, except one 30-ft. span over a driveway, which will be trussed. In this case they will use hookbolts to secure the castings. Girts 3x8 in. will be placed mid-height of the bents, and where the direction of flume changes four-post bents will be used.

*Bureau of Buildings, Portland, Ore.

Reconstructing Trestles and Bridges for Heavier Locomotives

The introduction of freight engines of the 2:8:2 class weighing 136½ tons (213 tons with tender) on the Illinois District of the Mobile & Ohio R.R., in 1912, necessitated the reinforcement and reconstruction of trestles and bridges. The standard trestles had spans of 12½ ft. between bents, with 12x14-in. caps and two 8x16-in. stringers under each rail. These were strengthened by adding a 7x16-in. stringer under each rail. This work cost $6895 for material and $3397 for labor.

The bridge over the Big Muddy River at Murphysboro, Ill., formerly consisted of three pin-connected through-truss spans (two of 108 ft. 9 in. and one of 196 ft.), with cut-stone piers. This was replaced with four 55-ft. deck girders (weight about 176,900 lb.) and one 196-ft. riveted Pratt through-truss (about 455,500 lb.), all of

Cooper's E-55 capacity. It cost $24,642 for metal in place (including inspection); falsework, $3047; constructing two new piers, 261 yd. plain concrete, $1857 (including excavation); remodeling four old piers, 406 yd. reinforced concrete, $3274 (including excavation). Total cost, $32,820.

The main piers were cut down several feet and inclosed with reinforced concrete, ½-in. rods being placed every 18 in. Dowel pins were driven in the joints of the masonry promiscuously. The concrete was made 12 in. thick on the channel side and 18 in. thick on the other side, and extended to a point at each end, thus completely inclosing the old masonry. The old piers were supposed to be founded on solid rock, but it was discovered that about half the south pier was on a layer 6 to 8 in. thick, underlaid with a pocket of shale 4 to 6 ft. thick. A pit was excavated to solid rock on the downstream end and filled in with concrete. Then a section about 3 ft. was cut out and filled in with concrete, and thus the work was carried on under the old pier and founded on solid rock.

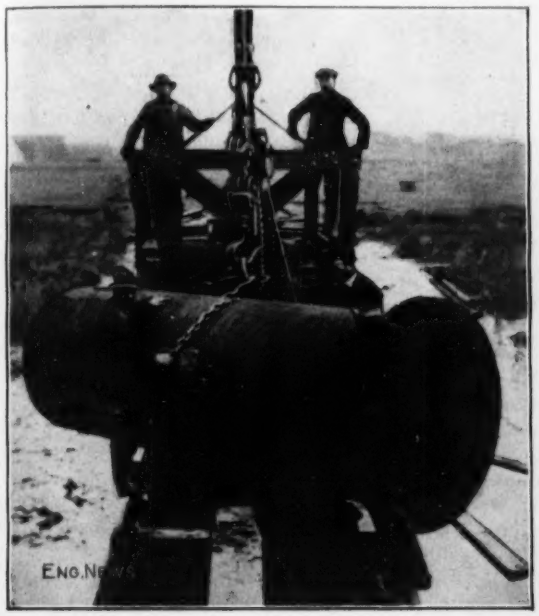


FIG. 1. A 48-IN. GAS MAIN LAID ON A PILE TRESTLE; LONG ISLAND CITY, NEW YORK

Three old 50-ft. through-girder bridges were replaced with standard trestles at an approximate cost of $2100. One 45-ft. deck-girder bridge was replaced with 20-ft. 3-in. concrete slabs reinforced with stringers from an old drawbridge, at a cost of $1667. One 31½-ft. deck-girder span was replaced at a cost of $536. All new work on this district was figured for Cooper's E-55 loading.

This work was done under the direction of B. A. Wood, Chief Engineer, and H. Austill, Jr., Bridge Engineer.

A Paving-Brick Carrier which is carried in a vertical position instead of in a horizontal, as is the familiar common-brick carrier, was recently placed on the market by the Frazier Machine Co., of McKeesport, Penn. The Walker Pavers Clamps, as the new carrier is called, automatically adjust themselves to any size paving bricks or blocks, and have capacity for four stacked either flat or on edge, as desired. Thus by means of two such carriers—one in each hand—a laborer can transport eight bricks or blocks at a time.

Laying a 48-In. Gas Main on a Pile Trestle by the Use of a Specially Designed Traveling Crane

A good example of ingenious pipelaying is the recent construction of a 48-in. gas-main pipe line across a swamp in Long Island City, Borough of Queens, New York City. The main was laid from Bridge St. to Webster Ave. under contract for the Consolidated Gas Co. by the Thomas Crimmins Contracting Co., of New York City.

In order to place the pipe at the correct grade with reference to a future street, and to avoid settlement, a timber trestle was built, consisting of bents of two piles each, spaced 6 ft. c. to c., longitudinally, and braced both crosswise and longitudinally with diagonal braces. The piles were capped with 8x8-in.x6-ft. timbers, on which the pipe was laid. The pipes are held in place by 6x6-in. oak wedges, 18 in. long, nailed to the caps. The trestle was built by Henry Steers, Inc., New York City, and completed before the pipelaying began. It was 4 or 5 ft. above the marsh, where the water was from 2 to 6 ft. deep; and the caps were made only 1 ft. 2 in. wider than the outside diameter of the bell of the pipe.

After considerable thinking the contractor for the pipelaying decided to roll the pipe from one end of the trestle and lay it from the other end of the trestle with a traveling crane. The pipe was hauled to the far end of the trestle by teams. Two 45-lb. railroad rails were laid across the caps of the trestle throughout its length on a 5-ft. 4-in. gage. On these rails the sections of pipe were rolled by two men to the near end of the trestle where the pipelaying began (Fig. 1).

For handling the pipe on the trestle a traveler was constructed approximately 24 ft. over all and built of 6x6-in. timbers with 2x8-in. braces on a traveling-car frame made of two 12-in. channels with double-flanged 12-in. iron wheels. As the pile caps were only 6 ft. long and it was essential for the traveling framework to clear the pipe already laid, it was necessary to offset the wheels as shown in Fig. 2.

The boom was fixed in position, made of an 18-in. I-beam, projecting about 9 ft. beyond the end of the car. A round iron yoke was fastened near the end of the boom, to which a 10-ton capacity chain block was attached. Sections of pipe 12 ft. long and weighing 8400 lb. were picked up, swung into line, and were placed in

position by moving the car a short distance back. Wedges were placed under the forward end of the traveler between the upper framework and the pipe, as shown in Fig. 2, and the uplift on the rear end was counterbalanced by a chain passing over the boom and under the pipe, the chain being brought taut by means of a turnbuckle, each time the crane was used. The traveler was moved a pipe-length ahead each time, and afterward a short distance back to fit the pipes together, by two or three men "putting their shoulders to the wheel."

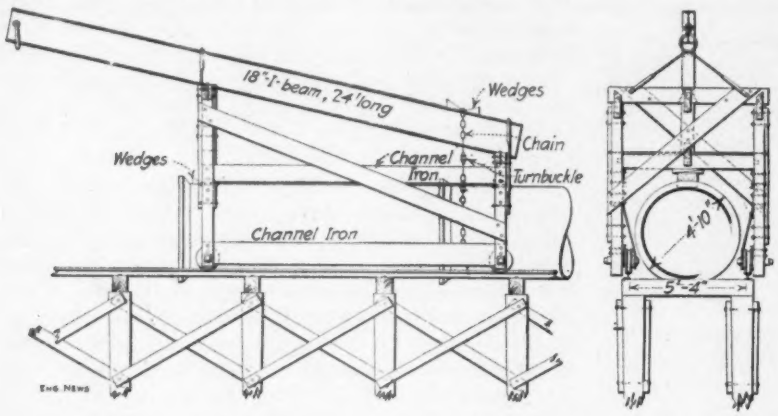


FIG. 2. DETAILS OF A SPECIALLY-DESIGNED TRAVELING CRANE FOR PLACING 48-IN. GAS MAIN ON A NARROW PILE TRESTLE OVER A SWAMP

On the average, 29 pipe-lengths a day were laid with this device, using a force of 6 men and a foreman. The calking was done by the gas company with a calking machine, recently come into use. The joints are calked with lead wool, and no special expansion joints in the pipe line are provided. None of the lengths of pipe are set absolutely home in the bells, there being at least ⅛-in. space left for expansion, which the nature of the lead-wool calking permits. F. N. Benedict is engineer for the Thomas Crimmins Contracting Co.

Reconstruction of the Foundation Under a Three-Story Brick Building

Failure to obtain engineering advice on what appears to be a mere detail for the mason, carpenter, or "practical" workman has often been a source of disaster to simple engineering structures. Many mistakes would be avoided and much money saved the public if the engineer were called in first instead of afterward—when the task is to repair instead of to prevent; or as the ancient proverb has it, "an ounce of prevention is worth a pound of cure." An example of this was the construction in 1911 of a 3-story brick high-school building at Waterville, Maine, on foundations which proved inadequate even before the structure was completed.

This building is a modern structure, 84x122 ft., with brick walls, wood floors supported on wooden joists, steel girders and steel H-section columns. The foundations were rubble masonry with footing courses which projected 8 or 10 in. each side of the brick walls (Fig. 3). In September, 1911, when the construction was well advanced, settlement of the columns was noticed, particularly columns Nos. 6 and 7 (see Fig. 1). Column No. 7 settled so much that it was thought advisable to allow no more load upon any part of the structure until an investigation could be made.

At this stage a firm of engineers, Sawyer & Moulton, of Portland, Maine, was called into consultation and directed to prepare plans and specifications for such reconstruction as should be considered necessary to prevent further settlement. This work was described by George L. Freeman, Principal Assistant Engineer for Sawyer & Moulton, in a paper read before Maine Society of Civil Engineers,* from which we have taken the following material.

SOIL—The building had been built on high sloping ground, where indications seemed to warrant an ordinary footing foundation. The basement excavations showed an apparently stable bed of sand. However, five wash-drill borings, made in the basement floor, so distributed as to obtain a general idea of the relative depths and slopes of the underlying strata, showed that the sand extended on an average only to 3 or 4 ft. below the footings. Below the sand was a stratum of very soft wet clay from 22 to 70 ft. thick. There was no firm material to a depth of nearly 80 ft. below the basement floor.

BEARING POWER OF SOIL—Load tests showed that the soil could not carry more than 1 ton per sq.ft., and that load only after proper drainage of the subsoil had been effected. With the existing footings the full dead and live-loads on the columns gave pressures from 4.42 to 6.27 tons per sq.ft., while the pressures under the wall footings averaged about 2 tons per sq. ft. With an allowable pressure of 1 ton per sq.ft. the column footings would have to be made from 9 to 10½ ft. square, and the wall-footing widths practically doubled, or made 8 to 10 ft., instead of 4 ft. and 5 ft. (see Fig. 3).

DESIGN AND CONSTRUCTION OF NEW FOOTINGS

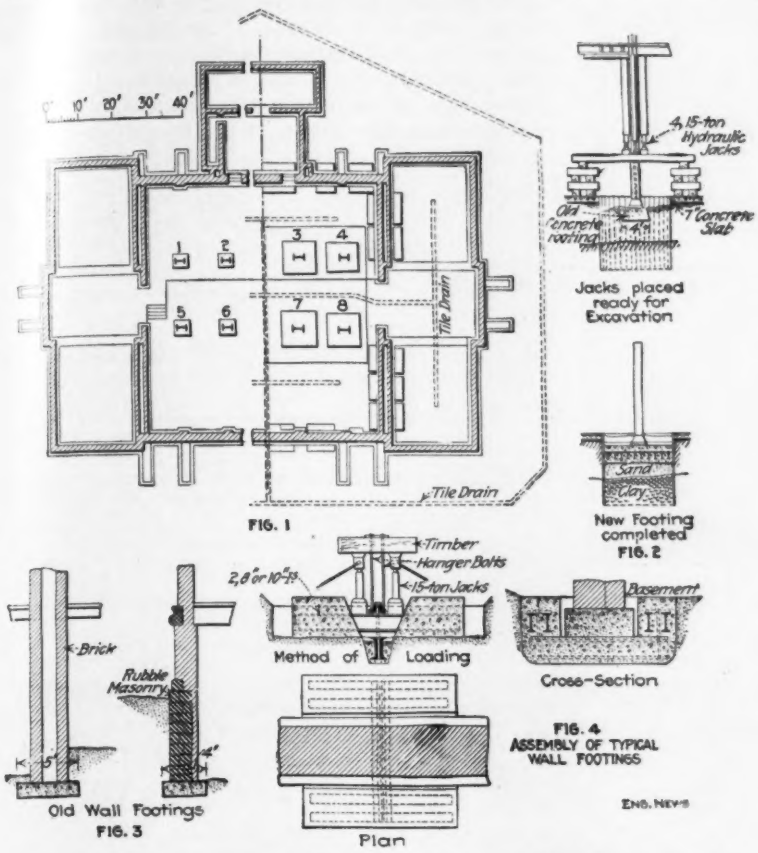
DRAINAGE—The first step was to build stone and tile drains entirely around the structure, and under the basement (see Fig. 1). All drains were excavated 36 in. wide to the surface of the clay stratum, the trench was filled with not less than 18 in. of coarse gravel or crushed stone, upon which tile sewer pipe with open joints was laid to a true grade. Over the pipe 12 in. of broken stone was placed, after which the backfill was carefully placed and tamped. All trenches were sheeted and the basement excavations close-sheeted during construction; the sheeting was removed as the backfilling progressed. Not over 25 lin.ft. of trench was opened at one time. This drainage system was entirely successful in freeing the subsoil of water.

COLUMN FOOTINGS—Wood-pile foundations were rejected because tests showed that the skin friction was of very little value until a considerable depth was reached; and because of limited headroom and risk of jarring.

The scheme adopted is shown in Figs. 2 and 4. The

*Proceedings for 1913, p. 88.

work was begun by boxing the column footings in square caissons made of 6-in. 11-lb. U. S. steel sheet-piling 10



PLAN AND CONSTRUCTION DETAILS OF OLD AND NEW FOUNDATIONS FOR WATERVILLE HIGH SCHOOL

ft. long. After the piling was driven, sections of the concrete floor of the basement were laid, sufficient to surround all the caissons. This floor was thoroughly reinforced to support temporary blocking, to carry struts and hydraulic jacks used to take the column loads off the footings (see Fig. 2). The reinforced-concrete floor also served to spread the load from the jacks and prevent the caisson walls from bulging.

When the jacks had relieved the columns of their loads the caissons were excavated to a depth of 2 ft. below the column plates and the old footings removed. The subsoil was then thoroughly tamped. Grillages were constructed of two 12-in. 31½-lb. I-beams resting across nine 7-in. 15-lb. I-beams (see Fig. 2), which were bolted to the bases of the columns. Concrete mixed 1:2½:5 was placed in the caissons to within 1½ in. of the tops of the 12-in. I-beams.

The jacks remained in place at least 8 days, after which they were released and the columns allowed to rest on the new footings. The columns were left in this condition until initial settlement had taken place, when they were again jacked up and steel wedges inserted under the base plates. Concrete and grout were then carefully poured in about the column bases to a height of 4 in. above the tops of the cross-girders. The remaining space to the basement-floor level was then filled with 1:2½:5 concrete or with well compacted cinders.

WALL FOOTINGS—It was first proposed to excavate short sections under the walls and build reinforced-concrete slabs below and projecting each side of the original footings, but this scheme was rejected because there was no way to apply the jacks and develop an initial compression beneath the new slabs. It also seemed unnecessary to build a new slab under a footing which was already good for at least half the area required.

It was finally decided to build a narrow footing each side of the original one, the additional part to be held down by needle beams projected through beneath the existing masonry. Provision was made to apply jacks and force the new slabs down upon the soil until a pressure of approximately 1 ton per sq.ft. had been developed beneath the new footings.

The earth was first excavated from a trench on each side of the walls, care being taken not to dig below the existing footings. A narrow trench was then cut through under the walls and a needle beam, made of two 12-in. or 15-in. channels, inserted and blocked up from beneath against the bottoms of the old footings. Steel hanger plates were next bolted to the ends of the needle beam, and the needle beam was then grouted in place, the trench under the wall being thoroughly filled with concrete (see Fig. 4). Two I-beam stringers were then bolted on each side to angles attached to the hanger plates across the tops of the stringers, and the whole was inclosed in concrete, forming two parallel slabs, one on each side of the old footing, each carrying a share of the wall load distributed to it through the needle beam and hangers.

The new footings were left 12 to 14 days before putting any load on them. At the end of this period 15-ton hydraulic jacks were set up as in Fig. 4, tension rods were connected through wood caps over the jacks to the flanges of the hanger angles, and the temporary bolts connecting the hanger angles to the I-beam stringers were removed. By operating the jacks the new footings were forced down until gages on the jacks indicated a pressure equivalent to a load on the footings of 1 ton per sq. ft.

Wedges were inserted between the tops of the stringers and the hanger flanges, and the jacks were removed, after which the whole was concreted.

The work was done under the direction of Harry E. Green, City Engineer of Waterville.

COST DATA—The cost exclusive of engineering was about $10,000. The total additional area of footing was 1500 sq.ft., and the cost per square foot of new footing was $6.67. The cost was divided approximately as follows: (1) 900 lin.ft. of tile and stone drain, $4500; (2) 40 tons of structural steel (I-beams, channels and piling), $3200; (3) 100 cu.yd. concrete, $2300.

A Stone-Handling Derrick Boat

An interesting piece of contractors' equipment, designed for rather special classes of work, is a derrick boat now in use for handling and transporting stone on river and harbor work. The hull or scow is of steel, carrying the load upon its deck, and having a derrick at each end. A view of the boat is shown in Fig. 1.

This derrick boat was built specially for the construction of rubble-mound breakwaters on the Great Lakes. For work of this kind very large quarry blocks are used in order to stand the force of the waves, the face blocks (of largest size) being laid usually so as to form a sort of rough paving or revetment. The depositing of the stone can be done only in comparatively calm weather, since with a barge rocking on the waves the handling of 10 to 30-ton stone blocks with a long boom is attended with difficulty and some danger, while the proper placing of the blocks is almost impossible. This boat was designed,

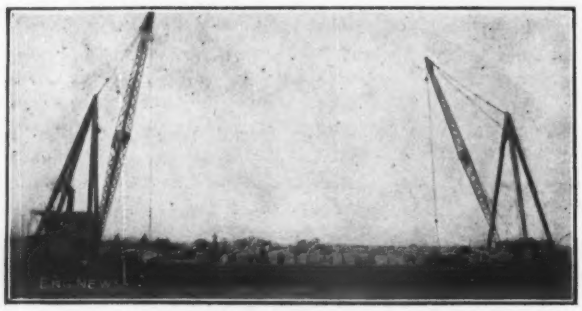


FIG. 1. DERRICK BOAT FOR RIVER AND HARBOR WORK

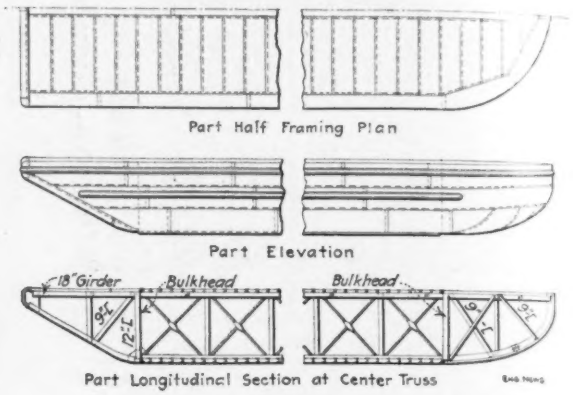


FIG. 2. STEEL HULL OF DERRICK BOAT

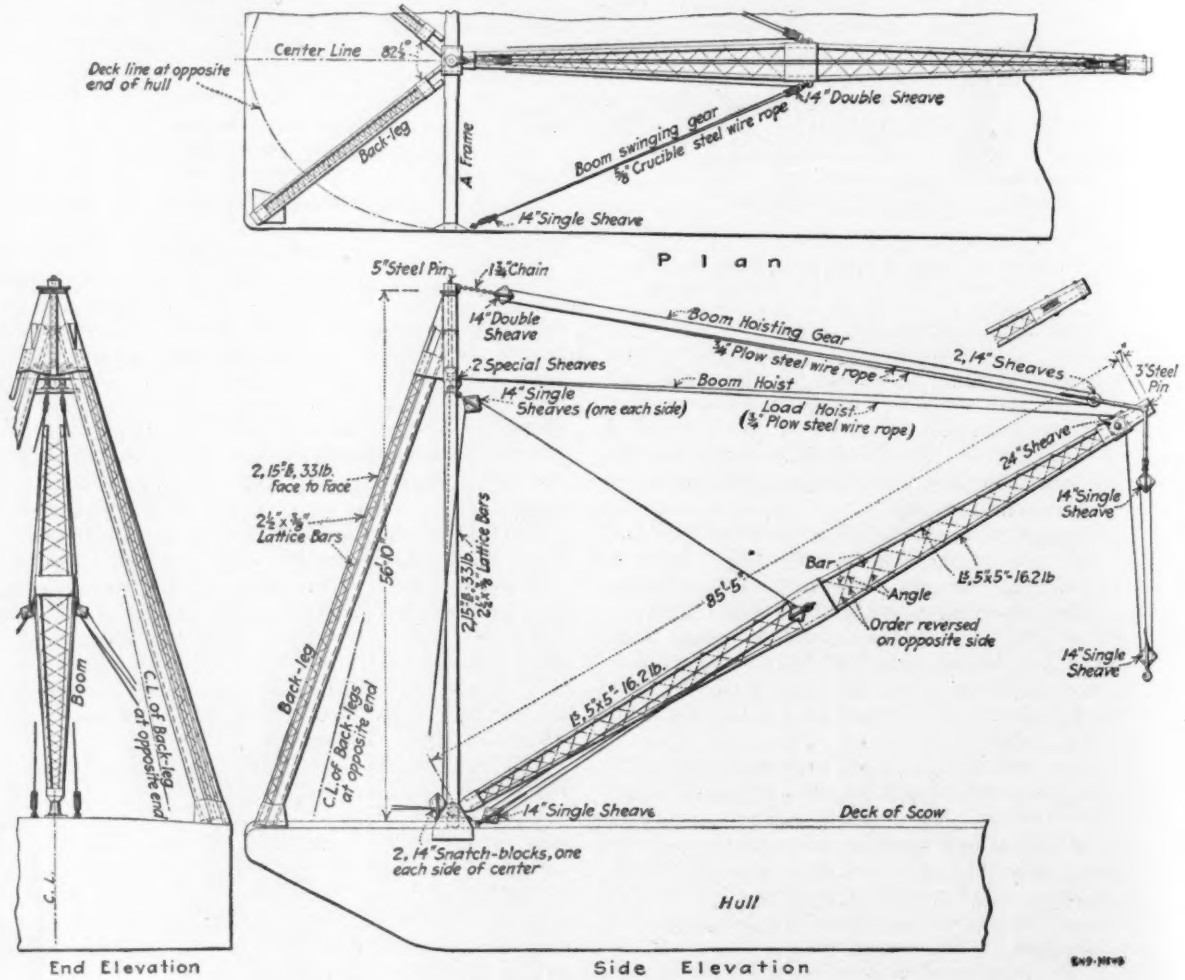


FIG. 3. 35-TON STEEL DERRICK FOR DERRICK BOAT

therefore, to carry a deck load of about 1200 tons of stone, so as to do as much work as possible when conditions are favorable.

The hull (Fig. 2) is of steel, 200 ft. long on the deck, 38 ft. beam, and 13 ft. deep. To carry its great load, it has five lines of longitudinal trusses. To the chords are attached the bottom cross frames and the deck beams, supported by back legs. Each leg of the A-frame is composed of two 15-in. channels, with the flanges inward and connected by lattice bars on both sides. The back legs are of similar construction, but with the latticing at top and bottom instead of on the sides. The boom is 85 ft. 5 in. long between end pins, and is of box-lattice construction, 48 in. square at the middle and 18 in. square

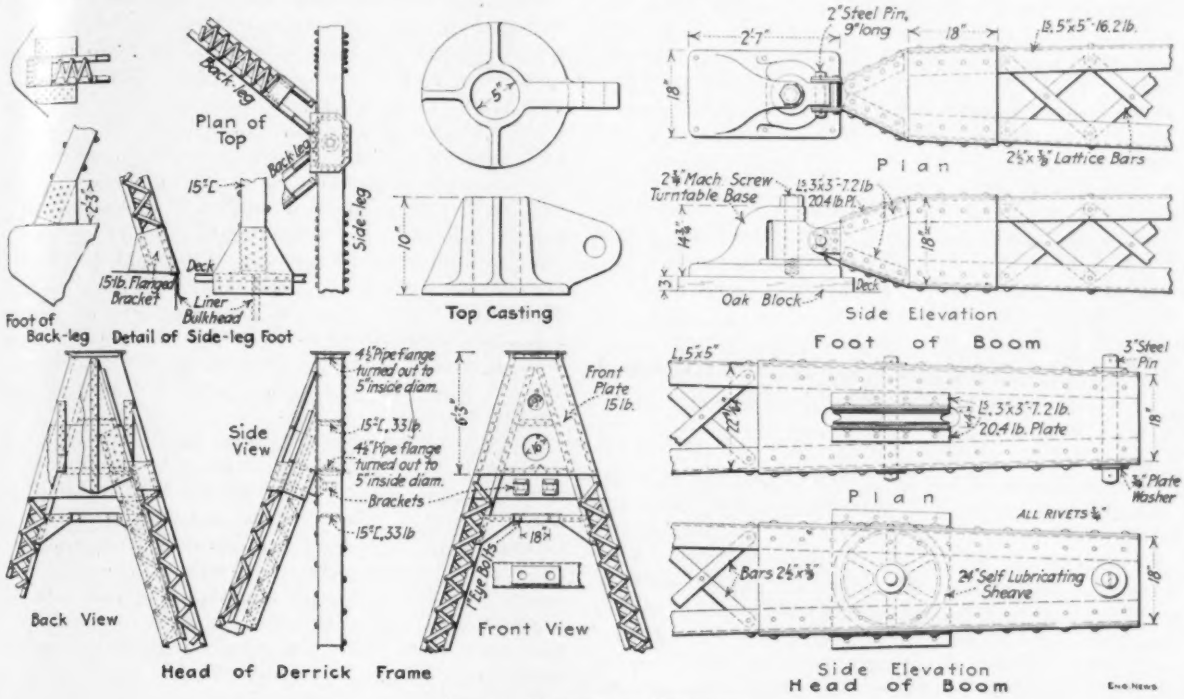


FIG. 4. DETAILS OF DERRICK

The center truss has an 18-in. plate and two flange angles for the top chord, and a single channel for the bottom chord. The others have channels for the chords, and all have posts of channels with diagonal bracing of angles. The floor beams are 9-in. channels, and the deck beams are 4x3-in. bulb angles.

There is a derrick at each end, as noted above. The construction and rigging are shown in Fig. 3, and the details in Fig. 4. The derrick has no mast, but the upper sheaves are carried by an A-frame 56 ft. 10 in. high,

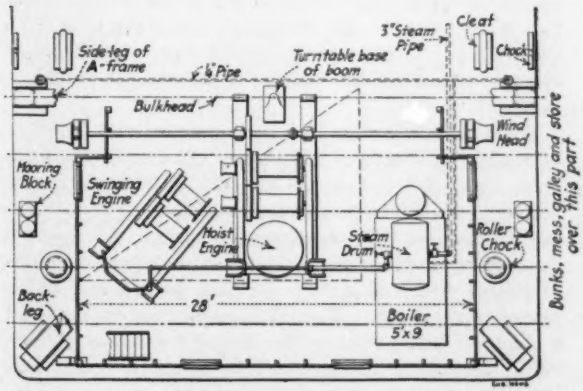


FIG. 5. ARRANGEMENT OF MACHINERY AT END OF DERRICK BOAT

(The machinery equipment is duplicated at the other end of the boat.)

at the ends. It has four chord angles 5x5 in., with latticing of 2½x2½-in. angles in one direction and 2½x⅝-in. bars in the opposite direction. For 25% of the length at each end, however, the latticing consists of bars only. Cover plates on all four sides are used at the middle and ends.

The heel of the boom is forked to fit the stub end of a cast-steel turntable, or swivel. The boom revolves in a vertical plane on a 2-in. horizontal steel pin passed through the forked end and the swivel. For the swinging movement, the swivel is secured by a vertical 2¾-in. pin to a cast-steel heelblock, or turntable base, which rests on a 3-in. oak block and is bolted to the deck framing of the hull. The hoisting capacity is 35 tons.

The machinery arrangement at one end of the boat is shown in Fig. 5, and this is duplicated at the opposite end, each derrick having its own machinery. To drain the hull there is at each end a pair of 3-in. siphon pipes, connected to 1¼-in. steam pipes entering near the bottom. The lower end of the siphon is fitted to a strainer bell resting on the floor plate, while the top is turned at an elbow and discharges through the side, just below the deck.

The derrick boat has been used on harbor improvement on the lakes, and on navigable rivers tributary to them. During 1911, it was employed on the construction of cribs and stone-filled pile piers for the extensive steel plant of the Indiana Steel Co., at Gary, Ind. While engaged on work for the Illinois Steel Co., at South Chi-

cago, it was used to remove (by means of a heavy stone grab) a quantity of 5 to 10-ton blast-furnace hobbs, which could not be removed by the ordinary dipper dredge. During 1912 it was at work on breakwaters at Ashtabula and Conneaut, Ohio.

For the past few months it has been part of the equipment on the construction of the new lock at Sault Ste. Marie, Mich. On this work it dredged and carried gravel for the concrete work; having been fitted with side boards for holding the load on the deck. It dredged this gravel from the bed of Whitefish Bay (up the St. Mary River) by means of orange-peel buckets operated from its derrick booms, and when loaded was towed down the river to the dock alongside of the storage pile and there unloaded.

This derrick boat was built by the Manitowoc Dry Dock Co., of Manitowoc, Wis., and cost about $48,000 (including machinery, rigging, etc.). It is owned by the Great Lakes Dredge & Dock Co., of Chicago, and for information respecting it we are indebted to the engineering department of that company.

Office Methods in Planning and Building a New Town

By J. F. Duling*

The following office methods were used in the planning and development of the industrial city of Torrance, Calif., the nucleus for a town of from twenty to thirty thousand people. This covers the laying out of the town, grading, paving, walks and curbs for 77,000 lin.ft. of street, the grading and paving of 15,000 lin.ft. of outside boulevards, the installation of a complete water system, a sewerage system, a sewage-treatment plant, and a street-lighting system, and the necessary work in connection with street and freight railways, gas system and telephone.

Starting with a piece of undeveloped land, all of the work just named was accomplished within one year, so the methods herein outlined have not had the opportunity of gradual improvement by years of trimming, but have proven quite adaquate for the work at hand.

Preliminary Details—The property being located some distance from the main office, it was early decided to lay out and compute all work possible in the office, before sending it to the field. Standard sizes of drawings were adopted for convenience in filing and binding into folders and reports: 8½x11 in. (letter size); 14x22 in.; 22x30 in.; 29x49½ in. (size of largest cabinet drawer used. Profiles and large drawings were kept in rolls. It was found practicable to follow the standard sizes except in a few cases, and even then one dimension of a standard size was often retained.

A filing cabinet for maps, 54x32 in., by 42 in. in height, having six drawers, 30x50x4 in., and three drawers 15x30 x4 in., inside measurements, and a rack 1x5x6 ft., with shelves for rolled maps, was made. Later a top section about one-half the depth of the lower section of this cabinet was added. This was divided into drawers of different sizes, a small cupboard for supplies, and a case for reference and field books. A second filing cabinet, almost a duplicate of the first, was added later.

A standard form of title for drawings was adopted, and a rubber stamp made for it. Opaque ink was used which blueprinted well. The title measured 3x5 in., several extra lines being allowed for notations of changes on drawings made from time to time. This form of title was used on all working drawings and proved to be a time saver as well as keeping uniformity in the work. Special single-stroke freehand-lettering pens were used for other title work and map lettering.

One large drafting table, 5x8 ft., mounted on horses, was made; on this was platted a large map of the property which was never taken from the board, but used as a reference and base map from which various tracings were made. Two adjustable tables with 2-in. tops were fitted with Universal drafting machines. They proved to be sufficient to handle all of the work adapted to their use. Six extra tables were added later and these were of 1-in. pine, with oak ends dovetailed in and mounted on horses. All tables had drawers and, with one exception, were uniform in size, measuring 36x60x40 in. in height. In order to facilitate the tracing work, a transfer table was made having a center of plate glass with an adjustable electric light beneath. This was found to be a great help, especially in tracing from blueprints, transferring data to thick paper drawings, and in tracing pencil sketches.

Contour Maps—The first and most important map to be made was a topographic map on a scale of 1 in. to 200 ft., with contour intervals of 2 ft., platted on mounted paper. This included not only the territory covered by the town itself but considerable adjacent territory so that future extension of streets and sewers could be provided for, particular attention being given to the drainage conditions. This was the main base and reference map upon which the proper locations of control streets were planned, of course with due consideration to outside conditions. Paper tracings were made from this map for preliminary sewerage-system studies.

A base map on a scale of 400 ft. to 1 in. was platted, to which the contours were pantagraphed from the larger map. In tracing contour maps, it was found more satisfactory to have the street plan and contours on separate sheets, using the contour tracing as a mask over the street plan in blueprinting. This had the advantage of furnishing prints with or without contours and the changes on the block plan did not necessitate erasure of contours.

Field Maps—The control streets being fixed, pencil studies were made of alternative street and block plans on tracing paper, and also on blue-line prints upon which the control streets had previously been platted. In all these studies, street drainage and the accessibility of sewers and other public utilities were constantly kept in mind.

After a street plan had been adopted, the town was divided in sections and a field map of each section platted on a scale of 1 in. to 100 ft. On these maps the subdivision into lots was planned, working out little details not possible on the smaller-scale maps. All computations were made, giving center-line distances and angles of streets, width of streets, parking, paving and railroad reservations, if any. The lot dimensions were also given, in fact all data necessary for laying out the work in the field. Duplicate blueprints of these and all other drawings were furnished the field engineers.

Profiles—After due consideration of the amount of rainfall, length of rainy season and condition of the

*625 S. Hill St., Los Angeles, Calif.

ground, it was found feasible, as well as desirable for economy, to use a surface-drainage system. To this end certain streets were located as drainage streets, with particular attention to directing the drainage away from the main business sections of the town. Care was taken to avoid as much as possible the collection of too much water at any one point within the town itself, rather having several points of delivery into the natural drainage channels.

The next step was to fix the grades on the control streets. For this purpose, profiles were platted from the field notes on a horizontal scale of 80 ft. to 1 in. Three ground lines (both sides and center lines) were shown; also a plan showing intersecting streets, curb lines, directions of drainage, cross-gutters, width of parking and pavement. A cross-section of the finished crown of street was shown on each profile. The parabola was taken as the form for the crown, and for convenience tables were worked up giving the values of the ⅛ points for different heights of crown. A crown height of 6 to 12 in. and a curb height above gutter of 6 to 10 in. were used, depending upon the width of pavements and drainage conditions, the flat crown and low curbs being favored.

A grade of 0.3% was taken as the minimum for good drainage conditions with concrete gutters. In the business section no grade exceeded 3% and in the residence district 6% was taken as the maximum. A constant slope of 3 in. in 10 ft. toward the roadway was used for sidewalks and parkings.

In setting grades, it was endeavored to have the business lots on a level with the sidewalk and residence lots at least 6 in. above the sidewalk. Vertical curves were used at all changes of grade, a set of tables being compiled for their rapid interpolation.

Public Utilities—It was early decided to locate public utilities wherever possible in the alleys to avoid constant tearing up of pavement for repairs and disfiguration of streets by pole lines. To this end each utility was given its location in the alley: the sewer the center, water and pole lines the south and west, and gas the north and east sides. Wherever necessary to put a utility in the street (with the exception of poles) it was placed in a 3-ft. space left for that purpose between curb and sidewalk.

In planning the public-utility systems, preliminary plans were first laid out with colored crayons on blueline prints from the field maps. After being accepted they were platted on a scale of 1 in. to 100 ft. on tracings taken from the field maps showing block plans and curb lines. All distances, angles, elevations, grades, fittings, etc., necessary for the staking out and laying of the line, were shown on these plans.

On account of the rapid progress of the work, it was not possible to have all sewer profiles run in advance of the setting of the grades, so temporary profiles were platted from the contour maps for that purpose. Concrete proved to be the cheapest material available for manholes and flushtanks. The designs were made circular, steel forms being used for the inside and the earth closely trimmed for the outside forms. Flushtanks were used at the ends of all lines. A depth of 4½ ft. from the flowline of the sewer to the surface of the ground was found to be the minimum depth desirable for building flushtanks. For 8-in. pipe, a minimum grade of 0.3% and a minimum depth of 4 ft. from flow line of sewer to finished crown of street at street crossing were used in order to be safe from crushing during grading operations. For convenience in relocating, the Y-branches in the sewers were placed approximately 4 ft. from the lot line on the lower side of the lot and all valves in the water system were located opposite the street or alley lines.

In the street-lighting system, all wires were carried in conduits in the space between the curb and the sidewalk. Lamp-posts between cross streets were located opposite lot lines. Various detail drawings were made to accompany the public-utility maps.

Filing Maps—A tracing from the base map upon a scale of 200 ft. to 1 in., giving dimensions of all lots, blocks, street widths, etc., as well as true bearings (in fact, a complete record of the town) was filed with the County Recorder.

Sales Maps—For the use of the sales department, a tracing was made on a scale of 1 in. to 200 ft. On this map were given sizes of all lots, width of streets and alleys and the location of existing and proposed railroads and street-car lines. The business, industrial and residential districts were indicated, also parks and other features of public interest. The sales map also has a small location map in one corner, showing the relative position of the property in reference to important near-by cities, towns and harbors, as well as important railway connections. These maps were photographed and reproduced on a small scale for public distribution, so care was used to keep all printing especially legible and not too small.

Calculations—The office work included many calculations. For the purpose of reference and record these were made in 150-page books. A book measuring 10x12 in., on quadruled yellow paper, proved to be the most suitable. All calculations were accompanied by sketches for the purpose of making the work clear.

In reducing the stadia notes the stadia slide rule was used. For all work requiring multiplication and division, calculating machines proved to be great timesavers, as well as decreasing the amount of errors over other methods. Two calculators were employed, each independently checking the other; they were also required to check all maps after completion.

Estimates—The larger portion of the work was done by contract; monthly payments were made on completed work only. The progress on each contract was reported weekly by the field engineers. Two estimators were employed to work up the estimates and render monthly statements. They also made all preliminary estimates in advance of the work.

In estimating the earthwork on streets, cross-sections were platted on cross-section paper to a scale of 5 ft. to 1 in. Sheets 16x25 in. were used and later filed in a looseleaf binder. The sections were taken 100 ft. apart or oftener as required by the irregularity of the ground. For convenience in platting, a templet cut from celluloid to conform with the shape of the crown of the completed street, as graded, was used; thus, the ground line and grade points of the curb being platted, the crown, gutter and parking slope were drawn with the aid of the templet. This made it unnecessary to cross-section the completed streets when they were reported finished to grade.

The area of the sections was taken with the planimeter and the yardage taken from double-end-area tables, compiled for 100-ft. sections. Tables were also com-

puted for estimating yardage over large areas, based upon the sum of the cut at the four corners of a 100-ft. square; also for 50- and 25-ft. squares. These tables not only saved much time, but increased the accuracy of the work. Small desk adding machines were used to advantage in summing up the quantities.

The contract work completed each month was shown in colored crayon on the progress maps, blue-line prints on cloth being used for this purpose. A different color was given to each month.

NOTES—Field notes were sent in to the office in the original field-books. Such of them as were needed in office work were copied into office books, proofed, and the field-book returned. This gave the added security of having two copies of all the important notes in case one copy was lost by fire or otherwise. In case of any discrepancies 'phone connections with the field office helped to straighten the matter out without serious loss of time.

INDEXING—In filing maps and notes an endeavor was made to use as simple a system as possible, as the size of the office did not warrant a filing clerk. Each map as drawn was given a number and entered into a number index. The numbers were given in regular order without reference to size of sheet. The index book was ruled and numbered in advance. In it opposite the number of the map were entered the date, title of drawing, scale, size of sheet, initials of draftsman, and the number of the drawer in which it was filed. The drawers in the filing cabinet were each given a number and also a heading, all drawings being grouped under headings. Three different-size drawers were allowed under each heading. An alphabetical index was also carried. This gave the drawing number as well as the number of drawer where filed.

All note-books were indexed individually, and in a general index. Each note-book was given a number and all like notes were grouped under headings as "Topography," "Street Profiles," etc. By this method it was possible to pick up almost any map without reference to the index, but merely by looking under the heading. The same thing was more or less true of notes also.

REPORTS—Each draftsman was required to keep a detailed report expressed in money of the amount spent on each job. These reports were turned in at the end of each week and a summary report made to the chief engineer, giving the cost of each job for the week. Thus the entire cost of any drawing could be obtained any time by referring to the reports.

SUMMARY—During the year's work over 500 drawings were made, including some heavy designs—as reinforced-concrete bridge, septic tank and water tower—besides many small designs.

⁂

Water Spots on Tracing Cloth—A correspondent asks us if there is any practical way known to restore the surface and transparency to tracing cloth which has been spotted with water. In the "Journal" of the American Society of Engineer Draftsmen for December, 1913, we find the following recipe: "By using a weak solution of celluloid dissolved in alcohol or ether." Possibly some of our readers have tried this, or know of some other means of accomplishing the same result.

⁂

Chicago Street-Car Accidents numbered 4158 during 1913, distributed as follows: Injured boarding cars, 561; injured alighting, 663; collision of cars, 91; collision with wagons, 722; collision with automobiles, 363; collision with motorcycles, 46; struck by cars, 1044; caught between cars, 27; falling off cars in motion, 348; miscellaneous, 323.

A Patented Soffit Reinforcement

A special soffit reinforcement for the concrete protection of steel beams and columns is now on the market and is being used in a number of buildings. It is essentially a steel-wire caging which grips the bottom flange of the steel section to be protected, providing a continuous line of reinforcement at a fixed and predetermined distance from the flange. Its distinguishing features are the compactness with which it can be shipped and stored, the firmness of its grip and the adequacy of the reinforcement it provides. Its main disadvantages are its relatively high cost and the occasional difficulty found in placing it.

The accompanying cut will give an idea of the material, which is known as the "Standardized Metal Caging." It is made up of a series of No. 12 wire clips bent in the section shown in heavy black, in Fig. 1, and electrically spot-welded into a continuous fabric of the form shown in Fig. 2. It comes packed close together as shown at the lower part of Fig. 2, in lengths of about 3 ft. In placing it, the end wire is caught over the end of the beam (or if the beam is wall bearing, over a special wire clip) and the section is pulled out by hand as shown in Fig. 2, until the side clips firmly grip the bottom flange of the beam. When this grip is firm the longitudinal spacing of the wires is uniform, as shown in Fig. 2. A packed 3-ft. section will then cover about 18 ft. of beam.

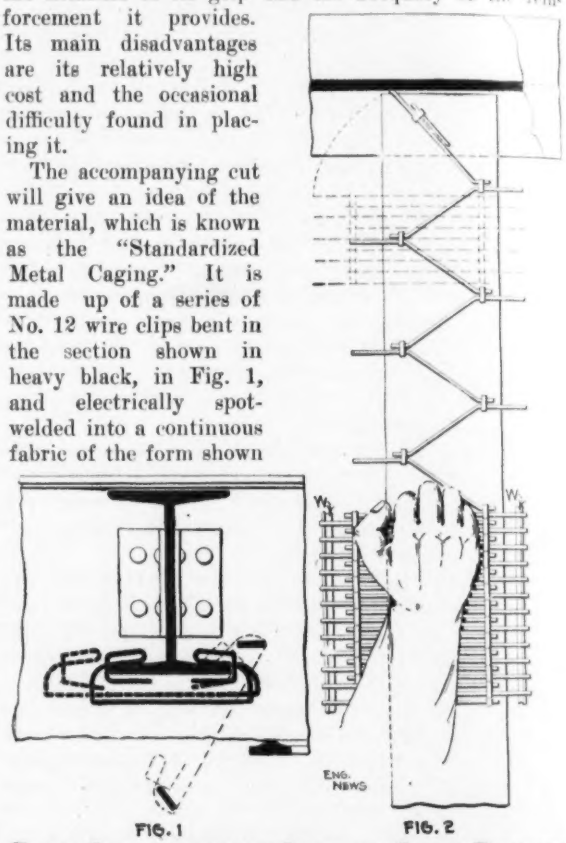


FIG. 1 FIG. 2

FIG. 1. SECTION THROUGH BEAM AND SOFFIT REINFORCEMENT. FIG. 2. UNDER VIEW OF BEAM WITH REINFORCEMENT

Fig. 1 shows the successive positions of the reinforcement. The light dotted lines show the position when first hung on the beam; the heavy dotted lines the position when pushed up preparatory to pulling out; and the heavy full line shows the final position, with a firm grip on the beam and reinforcement a definite distance from the flange. The letters *W* in Fig. 2 indicate wooden laths to give stiffness in packing and during erection.

The material is furnished in standard sizes, all, however, of the same size wire, but differing in the size of beam they are intended to fit. For use on double beams or on columns, additional wires of special shape are provided for the reinforcement of the sides of the member.

The cost of the caging is slightly higher than for the usual soffit clips, but this added cost is only a small percentage of the entire cost of fireproofing. In some instances where underneath trestles could not be used to work from, workmen straddling or lying on the beam to be covered have found some difficulty in pulling the reinforcement out to its final bearing, but this also is of minor importance compared to the effectiveness of the protection afforded.

The material is controlled and sold by the Mitchell-Tappen Co., 149 Broadway, New York City.

Estimating Grading Quantities on Revaluation

By M. H. Brinkley*

On account of the large amount of railway valuation which is to take place in the near future, quick methods of estimating grading quantities will be necessary. This is especially true if cuts and fills are measured up in the field. On most of the railways of the country adequate records of original cross-section quantities and cross-slopes or often center ground-line profiles do not exist. In such cases, the usual cross-section on revaluation is a four-point section, two points being at the intersection of the roadbed plane at the grade line with the side slopes and the other two points at the intersection of the side slopes with the ground surface.

The table shown herewith was drawn up by the writer and adopted on the revaluation of the New York Central R.R. and was also used on canal excavation in connection with the revaluation of hydraulic properties carried forward by J. G. White & Co. in California. This table is applicable to any side slopes or width of roadbed, the only condition being that the section shall be a four-point section with level base. Most sections on revaluation are of that type and irregular sections are infrequent except on very heavy work.

A section is assumed to be uniform for a volume extending halfway to the adjoining sections on either side. By looking twice in the table, the yardage per 100 ft. for any section may be taken out and placed in the notebook opposite the section. It is then a simple operation to multiply by the length, which is equal to one-half of the distance between the two adjoining sections. The yardage at each section is not exact for the volume considered, but the total yardage in any cut or fill is exact.

Take as an example the case where the field notes are as follows:

+7.0	0.0	0.0	9.0
18.0	12.0	11.0	19.0

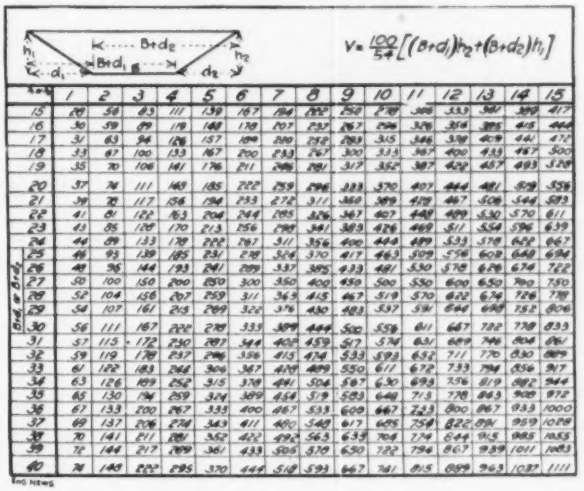
Then (see diagram on accompanying cut),

B = 23.0
d_2 = 8.0
d_1 = 6.0
B + d_1 = 29.0, h_1 = 7; and corresponding volume, from the table, is 483 cu.yd.
B + d_2 = 31.0, h_2 = 9; and corresponding volume, from the table, is 402 cu.yd.

The total volume per 100 ft. = 483 + 402 = 885 cu.yd.

Note also that the values $B + d_1$ and $B + d_2$ are taken from the above field notes as follows:

B + d_1 = 11 + 18 = 29
B + d_2 = 12 + 19 = 31.



Depth	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
15	28	56	83	111	139	167	194	222	250	278	306	333	361	389	417
16	30	59	89	119	148	178	207	237	267	296	326	356	385	415	444
17	31	63	94	126	157	189	220	252	283	315	346	378	409	441	472
18	33	67	100	133	167	200	233	267	300	333	367	400	433	467	500
19	35	70	106	141	176	211	246	281	317	352	387	422	457	493	528
20	37	74	111	148	185	222	259	296	333	370	407	444	481	519	556
21	39	78	117	156	194	233	272	311	350	389	428	467	506	544	583
22	41	81	122	163	204	244	285	326	367	407	448	489	530	570	611
23	43	85	128	170	213	256	298	341	383	426	469	511	554	596	639
24	44	89	133	178	222	267	311	356	400	444	489	533	578	622	667
25	46	93	139	185	231	278	324	370	417	463	509	556	602	648	694
26	48	96	144	193	241	289	337	385	433	481	530	578	626	674	722
27	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750
28	52	104	156	207	259	311	363	415	467	519	570	622	674	726	778
29	54	107	161	215	269	322	376	430	483	537	591	644	698	752	806
30	56	111	167	222	278	333	389	444	500	556	611	667	722	778	833
31	57	115	172	230	287	344	402	459	517	574	631	689	746	804	861
32	59	119	178	237	296	356	415	474	533	593	652	711	770	830	889
33	61	122	183	244	306	367	428	489	550	611	672	733	794	856	917
34	63	126	189	252	315	378	441	504	567	630	693	756	819	882	944
35	65	130	194	259	324	389	454	519	583	648	713	778	843	908	972
36	67	133	200	267	333	400	467	533	600	667	733	800	867	933	1000
37	69	137	206	274	343	411	480	548	617	685	754	822	891	959	1028
38	70	141	211	281	352	422	493	563	633	704	774	844	915	985	1055
39	72	144	217	289	361	433	506	578	650	722	794	867	939	1011	1083
40	74	148	222	296	370	444	518	593	667	741	815	889	963	1037	1111

Eng. News

Earthwork Volumes for Four-Point Sections

If instead of the yardage extending to the halfway points on each side of a section the yardage is desired between two sections, it is easily obtained by taking ½ the sum of the two volumes, which gives the yardage per 100 ft. and with the distance known the total exact yardage is obtained. If the table is used in the latter manner it might be more convenient to have it made up with ½ of the yardages given in the table. The table should be extended in either direction as only a small section is shown to illustrate its application.

The work with this table is very rapid and astonishing progress can be made by its use.

Shopwork on Wind Girders for Tier-buildings—In regard to the fabrication of structural steel for high buildings, on all buildings that I have inspected in which windbrace girders were required, I have had a hard time trying to make the shop keep the end wing plates square and parallel. Windbrace girders are very often thrown out of square if the riveter does not exercise care and drifts a bad hole in the wing plates or end connection angles, and it often happens that the ends are not flush. If the architects would specify that the girders must be riveted in a frame, the result would be good workmanship in every respect, and time-saving to the shop. Most of the girders for the Field Annex building were put up in a frame and they were fine; the girders that were not put in the frame either had to be milled square or the wing angles cut off and squared up. The girders placed in a frame were riveted at a lower cost and better results obtained for the customer.

[From report by John Sheron, Inspector, to R. W. Hunt Co.]

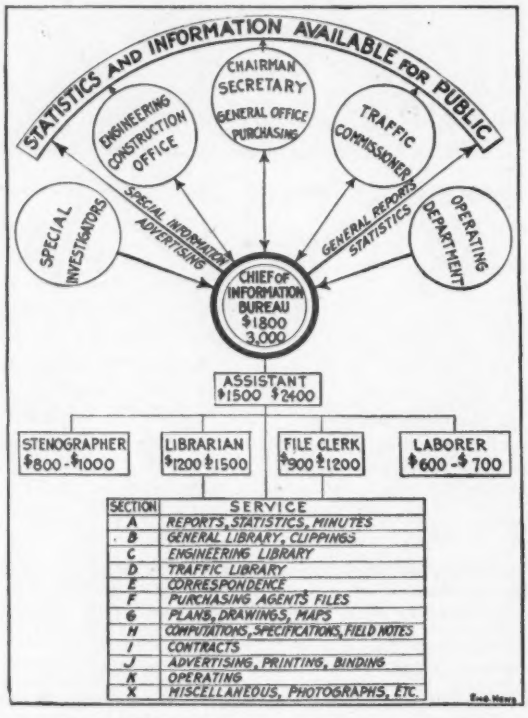
A Dump Car for Construction Work now being introduced has the sides hinged at the bottom edge, so as to fall down as the car body tilts, while in many other designs the side swings up clear of the body. In the new design, the end forms an extension of the tilted floor, so as to deliver the material clear of the track and wheels. The car may be dumped and righted by hand or by compressed air, and in the latter case the latches are operated by an auxiliary cylinder. The horizontal dumping cylinders are mounted on fixed-end frames extending above the end sills; they move with the body, the pistonrod being attached to the fixed frame. They will dump the car to either side, as required. These cars are made in sizes of 12 to 20 cu.yd. capacity, the latter holding 30 yd. with a heaped load, and being rated at 100,000-lb. capacity. They are built by the Clark Car Co., of Pittsburgh, Penn.

*Assistant Engineer, Railroad Commission of the State of California, San Francisco, Calif.

An Efficient Information Bureau for Public Works Commissions

By Frank H. Jones*

Chief among the overlooked or otherwise neglected features in the organization of public-works boards, improvement commissions and investigation bureaus is the care and availability of collected and compiled data for general office and public use. Neglect of this element gives rise in the public mind to a negative attitude of the worth of such data. Limited and unimportant indeed is the work of such boards and commissions whose records and data are not worth the care and organization necessary to place them at the disposal of the entire official force, the employees, and the general public.



Organization Diagram for an Information Bureau for a Board of Public Works

The organization scheme shown herewith is designed for a public-works board having jurisdiction over economic investigations, engineering and construction work, operation and management. Responsibility for data and records rests solely with the Chief of the Bureau, who prepares reports, advertising matter, oversees all printing and binding, compiles catalogs, bibliographies and acquires outside data of interest to the work of the board that do not come through the regular channels. Directly under him, with a thorough working knowledge of every phase of classification and filing, is the assistant to the chief, who has charge of all matters of distributing and recording. The librarian has direct charge of sections A, B, C and D, and the file clerk of sections E, F, G, H, I, K and X. The stenographer prepares index cards, manuscripts and does general office work, while the laborer is used as a messenger and assists in the office routine.

Under such an organization the Bureau not only relieves the general and other offices of the routine of filing and caring for data but insures standardization of records and creates responsibility for such records. Modification and expansion in the necessary employees and the salaries can be made as work decreases or increases, the general scheme, however, of definite responsibility and segregation of filing forces being maintained.

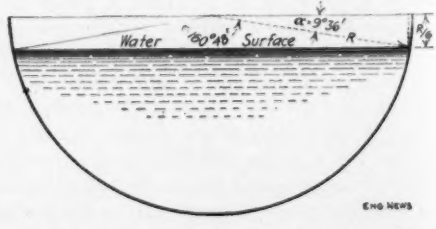
*95 Partridge Ave., Winter Hill, Mass.

The Discharge Capacity of Semicircular Steel Flumes

By E. A. Moritz*

Steel flumes have ceased to be a novelty and their increasing use has created a necessity for a more convenient means of calculating discharges than, to the writer's knowledge, is now available. The various manufacturers' tables are not sufficiently complete for engineers' use, as they are restricted to flumes flowing either full or with a fixed freeboard and to particular values of Kutter's n. Different local conditions may necessitate the use of varying freeboards, even for the same size of flume, and individual opinions also vary as to the proper freeboard for a given size of flume, even under the same conditions. The value of Kutter's n for steel flumes is also a mooted question and is therefore subject to variation according to individual opinion. Only a few experiments have been made in regard to this and these have been quite limited in their scope, but such as have been made indicate that the value is about 0.012 for the smoothest and 0.015 for the roughest flumes. With the continual improvements that are being made in the joints, it is probable that 0.012 is a safe value for the smoothest flumes, provided that sufficient freeboard is allowed under maximum flowage conditions. It is too early to obtain data as to the effect of age on the carrying capacity of steel flumes, and for this and other reasons it is better to be somewhat conservative in their design.

Tables I and II give the discharges and corresponding velocities for the standard sizes of flumes now manufactured, calculated by the Kutter formula, for values of n of 0.012 and 0.015, respectively. These tables are based on a freeboard of 1 in. for each foot in diameter,



Section of Semicircular Flume, Showing Hydraulic Conditions upon Which Tables 1 and 2 Are Based

or, in other words, $\frac{1}{12}$ of the diameter, which is probably as much as would be required by the most conservative engineers. Thus, for a 7-ft. diameter flume, the discharges given in the tables obtain when the water surface is 7 in. from the top; for a 12-ft. 1-in. diameter flume, the discharges given in the tables obtain when the water surface is 12.08 in. from the top.

Freeboard, or clearance of water surface below the top of the flume, is necessary for a number of reasons: (a)

*Engineer, U. S. Reclamation Service, Washington, D. C.

to provide for passage of floating matter such as large weeds, sticks, boards, etc., under the crosspieces; (b) to allow for uncertainties in the value of n; (c) to allow for decrease in carrying capacity with age; (d) to allow for periodic fluctuations in the water level. Each of these must be given due consideration, and peculiar local conditions may suggest additional requirements affecting the freeboard.

The uniformly varying freeboard on which the discharge tables are based allows the use of a constant coefficient for obtaining the discharge for any other freeboard less than 1 in. per ft. of diameter. This may be demonstrated as follows (for clearness, see accompanying figure):

Let R be the radius of the flume and α the angle made by the line joining the center of the circle with the intersection of the water surface with the side of the flume.

Then $\sin \alpha$ = a constant = $\frac{1}{6}$.

Therefore $\alpha = 9° 36'$.

The angle subtended by the wetted perimeter is

$$180° - 2\alpha = 160° 48'.$$

The length of wetted perimeter, therefore, is $2\pi R \times \frac{160° 48'}{360°} = 2.807\ R$.

The area of the segment is $1.24\ R^2$.

The hydraulic radius r, therefore, is $\frac{1.24\ R^2}{2.807\ R} = 0.442\ R$.

By substitution in the Chezy formula we then have

$$Q = A c \sqrt{rs} = 0.825 c\ R^{\frac{5}{2}} S^{\frac{1}{2}}$$

In the formula $Q = A\ c\ \sqrt{rs}$ the discharge varies directly as the area of A and the coefficient c, and as the square root of the hydraulic radius r. We may then obtain a comparison between discharges of flumes with 1 in. freeboard per ft. of diameter and flumes flowing full, or without freeboard, as follows:

(1) One in. freeboard per ft. diameter—
$r = 0.442\ R$;
$A = 1.24\ R^2$;
c = about 1½% smaller than for full flume.

(2) Flume flowing full—
$r = 0.5\ R$;
$A = 1.57\ R^2$;
c = about 1½% larger than for flume with freeboard as above.

The increase in discharge of (2) over (1) due to the increased hydraulic radius is

$$\left(\frac{0.5\ R}{0.442\ R}\right)^{\frac{1}{2}} - 1 = 6.5\%$$

The increase in discharge of (2) over (1) due to increased area is

$$\frac{1.57\ R^2}{1.24\ R^2} - 1 = 26.5\%$$

The increase in discharge of (2) over (1) due to increase in value of c (caused by increase in hydraulic radius) is about 1½%. To obtain the total increase in discharge of the full flume over the same flume running with a freeboard of 1 in. per ft. of diameter, we take the product of the three separate factors = $1.265 \times 1.065 \times 1.015 = 1.36$, showing that any semicircular flume will carry 36% more when running full than when running with a freeboard of 1 in. per ft. of diameter.

To obtain the discharge, then, of any flume flowing full, we have only to multiply the figure obtained from either of the tables by 1.36. This figure itself is not of much practical use, but by a similar process to the above it can be shown that for any intermediate freeboard a linear variation may be assumed. This is quite evident even without the support of figures. Therefore, to obtain the discharge of flumes having a freeboard of only ½ in. per ft. diameter of flume, we multiply the figures in the table by $1 + (0.36 \times \frac{1}{2}) = 1.18$; for a freeboard of ¾ in. per ft. diameter of flume we multiply the figures in the table by $1 + (0.36 \times \frac{1}{4}) = .09$, etc.

For example: in Table I the discharge of a 7-ft. diameter flume on a slope of 0.0004 is 51.5 cu.ft. per sec. This is for a freeboard of 7 in. or 1 in. per ft. diameter; if it were desired to allow only 3½ in. or half as much freeboard the discharge would be $51.5 \times 1.18 = 60.8$ cu.ft. per sec. If it were desired to allow 6 in. freeboard we would multiply by $1 + (0.36 \times \frac{1}{7}) = 1.05$ and the discharge would be $51.5 \times 1.05 = 54.1$.

If it is desired to use a value of n of 0.013 or 0.014, the coefficients given in the last two columns of Table I may be used in connection with the table. The figures in these two columns give the ratio of discharge on the basis of $n = 0.013$ and 0.014 to the discharge for $n = 0.012$. This ratio varies with the hydraulic radius and each factor applies to the figures in the table in the horizontal line in which the factor occurs. As an example: find the discharge of a 7-ft. flume on a slope of 0.0004 when $n = 0.014$ and the desired freeboard is 5 in. From the table we read, as in the previous example, that the discharge for 7 in. freeboard is 51.5 cu.ft. per sec. For a 5-in. freeboard the discharge will be $51.5 \times 1 + (0.36 \times \frac{2}{7}) = 51.5 \times 1.1 = 56.6$ for $n = 0.012$. From the table we now read the multiplier for 7-ft. flume for $n = 0.014$ to be 0.849, making the discharge $56.6 \times 0.849 = 48$ cu.ft. per sec. for a 7-ft. diameter flume with 5-in. freeboard and $n = 0.014$.

The problem usually presented is to find the size of flume required to carry a given quantity on a given slope. Assume that it is required to discharge 100 cu.ft. per sec. The value of n considered applicable is 0.014. The available slope is 0.0005 and the freeboard shall be not less than 6 in. An inspection of the table shows that an 8-ft. 11-in. flume will discharge 109 cu.ft. per sec. when $n = 0.012$ and the freeboard is 8.9 in. The reduction factor for $n = 0.014$ is 0.852. The reduction factor to 6-in. freeboard is $1 + \left(0.36 \times \frac{2.9}{8.9}\right) = 1.12$.

The discharge of this flume under the required conditions therefore is $109 \times 1.12 \times 0.852 = 104$ cu.ft. per sec. This flume is therefore somewhat larger than is required, but an inspection of the next smaller size shows that it would be much too small. The 8-ft. 11-in. diameter flume is therefore selected.

The foregoing examples explain sufficiently the method of using the tables and serve to show that they are quite flexible no matter what angle the problem is approached from.

The use of the various coefficients makes the application of the tables general and avoids the necessity of making original calculations by means of the cumbersome process required by the formula. For various reasons it is desirable that the velocity of the water in the flume be known approximately, for which reasons this

Tables for Flow of Water in Semicircular Flumes, for Four Values of Kutter's n

Formula $Q = 0.825\ c\ R^{\frac{1}{2}}\ s^{\frac{1}{2}}$; Freeboard taken as one-twelfth the diameter.
Values of Q in cu.ft. per sec.; V in ft. per sec.

TABLE I. VALUES FOR n = 0.012, AND MULTIPLIERS FOR n = 0.013 AND 0.014

Diam. (2 R. ft. & in.)	Flume Area, sq.ft. Total	Flume Area, sq.ft. Water	Hydr. radius (r, ft.)	Slope, s = 0.0001 Q	0.0001 V	0.0002 Q	0.0002 V	0.0003 Q	0.0003 V
1 0	0.393	0.310	0.221	0.11	0.35	0.18	0.58	0.22	0.71
1 3½	0.634	0.500	0.281	0.23	0.46	0.34	0.68	0.42	0.84
1 11	1.43	1.13	0.425	0.72	0.64	1.07	0.95	1.33	1.18
2 6½	2.54	2.01	0.556	1.61	0.80	2.38	1.18	2.97	1.48
3 2½	3.97	3.13	0.704	2.90	0.92	4.29	1.37	5.29	1.69
3 10	5.73	4.52	0.851	4.85	1.07	7.11	1.57	8.85	1.95
4 5½	7.81	6.16	0.988	7.37	1.19	10.7	1.74	13.2	2.14
5 1	10.17	8.03	1.125	10.5	1.31	15.2	1.89	18.7	2.33
5 8½	12.89	10.17	1.266	14.3	1.41	20.8	2.04	25.5	2.51
6 4½	15.88	12.53	1.408	19.1	1.52	27.6	2.20	34.1	2.72
7 0	19.24	15.18	1.550	24.8	1.63	35.9	2.36	44.3	2.92
7 7½	22.92	18.10	1.692	31.3	1.73	45.3	2.50	55.5	3.06
8 4	27.25	21.55	1.847	39.9	1.85	57.3	2.66	70.1	3.25
8 11	31.19	24.66	1.970	47.7	1.93	68.5	2.77	83.9	3.40
9 6½	35.93	28.36	2.118	57.4	2.03	82.4	2.91	101	3.56
10 2	40.69	32.10	2.250	67.8	2.11	96.6	3.01	118	3.67
10 10	46.08	36.36	2.400	80.2	2.21	115	3.16	141	3.88
11 5½	51.66	40.80	2.538	93.5	2.29	133	3.26	163	3.99
12 1	57.50	45.40	2.675	108	2.38	154	3.39	189	4.16
12 8½	63.80	50.35	2.817	124	2.46	176	3.50	216	4.28

(TABLE I CONTINUED)

Flume diam.	Slope, s = 0.0004 Q	0.0004 V	0.0005 Q	0.0005 V	0.0006 Q	0.0006 V	0.0008 Q	0.0008 V	0.0010 Q	0.0010 V
1 0	0.26	0.84	0.29	0.93	0.32	1.03	0.38	1.22	0.42	1.35
1 3½	0.50	1.00	0.56	1.12	0.62	1.24	0.72	1.44	0.81	1.62
1 11	1.57	1.39	1.76	1.56	1.94	1.72	2.24	1.98	2.50	2.21
2 6½	3.46	1.72	3.87	1.92	4.28	2.13	4.95	2.46	5.53	2.75
3 2½	6.17	1.97	6.90	2.20	7.62	2.43	8.80	2.81	9.84	3.14
3 10	10.3	2.27	11.5	2.54	12.7	2.80	14.7	3.25	16.4	3.62
4 5½	15.3	2.48	17.1	2.77	19.0	3.08	21.9	3.55	24.5	3.97
5 1	21.8	2.71	24.4	3.04	26.9	3.35	31.1	3.87	34.7	4.32
5 8½	29.7	2.92	33.2	3.26	36.7	3.60	42.3	4.16	47.3	4.65
6 4½	39.6	3.16	44.3	3.54	49.0	3.91	56.6	4.52	63.3	5.05
7 0	51.5	3.39	57.6	3.79	63.6	4.18	73.5	4.83	82.0	5.40
7 7½	64.5	3.56	72.2	3.98	79.5	4.39	91.8	5.07	103	5.68
8 4	81.5	3.78	91.2	4.23	101	4.68	117	5.43	130	6.03
8 11	97.4	3.94	109	4.41	121	4.90	139	5.63	156	6.32
9 6½	117	4.13	131	4.62	145	5.12	167	5.89	187	6.60
10 2	137	4.26	153	4.76	170	5.29	196	6.10	219	6.82
10 10	163	4.48	182	5.00	201	5.53	232	6.38	260	7.15
11 5½	188	4.60	210	5.14	232	5.68	268	6.56	299	7.32
12 1	218	4.80	244	5.37	267	5.88	308	6.78	345	7.58
12 8½	250	4.96	280	5.56	303	6.01	350	6.95	394	7.83

(TABLE I CONTINUED)

Flume diam.	Slope, s = 0.0012 Q	0.0012 V	0.0015 Q	0.0015 V	0.002 Q	0.002 V	0.003 Q	0.003 V	0.004 Q	0.004 V
1 0	0.46	1.48	0.52	1.68	0.60	1.93	0.73	2.35	0.84	2.71
1 3½	0.88	1.76	0.99	1.98	1.14	2.28	1.40	2.80	1.62	3.24
1 11	2.75	2.43	3.08	2.72	3.55	3.14	4.35	3.85	5.02	4.44
2 6½	6.11	3.04	6.83	3.40	7.90	3.93	9.66	4.80	11.2	5.56
3 2½	10.8	3.45	12.1	3.86	13.9	4.43	17.0	5.42	19.7	6.28
3 10	17.9	3.96	20.0	4.42	32.1	5.10	28.3	6.25	32.7	7.23
4 5½	27.0	4.38	30.2	4.90	35.2	5.71	43.2	7.00	49.8	8.10
5 1	38.0	4.73	42.5	5.28	49.0	6.10	60.2	7.50	69.5	8.65
5 8½	51.8	5.10	58.0	5.70	67.0	6.58	82.0	8.06	94.6	9.30
6 4½	69.2	5.52	77.3	6.16	89.3	7.12	109	8.70	126	10.0
7 0	89.9	5.92	101	6.65	116	7.63	142	9.35	164	10.8
7 7½	113	6.25	126	6.96	146	8.06	179	9.89	206	11.4
8 4	142	6.58	159	7.37	184	8.53	225	10.4	260	12.1
8 11	170	6.88	191	7.73	220	8.91	270	10.9	311	12.6
9 6½	205	7.24	229	8.08	265	9.35	324	11.4	374	13.2
10 2	240	7.47	268	8.34	310	9.65	379	11.8	438	13.6
10 10	284	7.80	317	8.72	367	10.1	449	12.4	518	14.3
11 5½	328	8.03	367	8.98	424	10.4	520	12.7	600	14.7
12 1	377	8.30	422	9.30	487	10.7	596	13.1	688	15.1
12 8½	432	8.58	483	9.60	558	11.1	684	13.6	792	15.7

(TABLE I CONTINUED)

Flume diam.	Slope, s = 0.005 Q	0.005 V	0.006 Q	0.006 V	0.008 Q	0.008 V	0.010 Q	0.010 V	Multipliers for n = .013	Multipliers for n = .014
1 0	0.95	3.06	1.04	3.35	1.20	3.87	1.34	4.32	0.903	0.822
1 3½	1.82	3.64	1.99	3.98	2.30	4.60	2.57	5.13	0.905	0.826
1 11	5.66	5.00	6.20	5.48	7.16	6.33	8.01	7.08	0.908	0.832
2 6½	12.6	6.26	13.8	6.86	15.9	7.90	17.8	8.85	0.910	0.836
3 2½	22.2	7.08	24.3	7.75	28.1	8.96	31.4	10.0	0.912	0.839
3 10	37.0	8.17	40.5	8.95	46.8	10.4	52.3	11.6	0.913	0.842
4 5½	55.6	9.02	61.0	9.90	70.4	11.4	78.7	12.7	0.914	0.844
5 1	78.1	9.72	85.6	10.7	98.8	12.3	110	13.7	0.915	0.846
5 8½	107	10.5	117	11.5	135	13.3	151	14.8	0.916	0.847
6 4½	142	11.3	156	12.4	180	14.4	201	16.0	0.917	0.848
7 0	185	12.2	203	13.4	234	15.4	262	17.2	0.918	0.849
7 7½	231	12.8	253	14.0	292	16.1	327	18.1	0.918	0.850
8 4	292	13.5	320	14.8	370	17.2	413	19.2	0.919	0.851
8 11	348	14.1	381	15.4	440	17.8	492	19.9	0.919	0.852
9 6½	421	14.8	461	16.3	532	18.8	595	21.0	0.919	0.853
10 2	493	15.3	540	16.8	624	19.4	697	21.7	0.920	0.853
10 10	583	16.0	639	17.6	738	20.3	825	22.7	0.920	0.854
11 5½	675	16.5	740	18.1	855	20.9	955	23.4	0.920	0.855
12 1	775	17.1	850	18.7	980	21.6	1095	24.1	0.921	0.855
12 8½	888	17.6	973	19.3	1125	22.3	1255	24.9	0.921	0.856

TABLE II. VALUES FOR n = 0.015

Diam. (2 R. ft. & in.)	Flume Area, sq.ft. Total	Flume Area, sq.ft. Water	Hydr. radius (r, ft.)	Slope, s = 0.0001 Q	0.0001 V	0.0002 Q	0.0002 V	0.0003 Q	0.0003 V
1 0	0.393	0.310	0.221	0.08	0.26	0.14	0.43	0.19	0.53
1 3½	0.634	0.500	0.281	0.17	0.34	0.26	0.52	0.32	0.64
1 11	1.43	1.13	0.425	0.55	0.48	0.82	0.72	1.01	0.90
2 6½	2.54	2.01	0.556	1.23	0.61	1.82	0.90	2.25	1.13
3 2½	3.97	3.13	0.704	2.23	0.71	3.31	1.06	4.07	1.30
3 10	5.73	4.52	0.851	3.75	0.83	5.50	1.22	6.85	1.51
4 5½	7.81	6.16	0.988	5.73	0.93	8.32	1.35	10.3	1.67
5 1	10.17	8.03	1.125	8.16	1.02	11.8	1.47	14.5	1.81
5 8½	12.89	10.17	1.266	11.2	1.10	16.3	1.60	20.0	1.97
6 4½	15.88	12.53	1.408	15.0	1.20	21.7	1.73	26.8	2.14
7 0	19.24	15.18	1.550	19.6	1.29	28.3	1.86	35.0	2.31
7 7½	22.92	18.10	1.692	24.8	1.37	35.4	1.96	33.9	2.42
8 4	27.25	21.55	1.847	31.6	1.47	45.4	2.11	55.5	2.58
8 11	31.19	24.66	1.970	38.0	1.54	54.4	2.20	66.5	2.70
9 6½	35.93	28.36	2.118	45.6	1.61	65.5	2.31	80.3	2.83
10 2	40.69	32.10	2.250	53.9	1.68	76.8	2.39	94.0	2.92
10 10	46.08	36.36	2.400	63.8	1.76	91.5	2.52	112	3.08
11 5½	51.66	40.80	2.538	74.5	1.82	106	2.60	130	3.18
12 1	57.50	45.40	2.675	86.1	1.90	123	2.70	151	3.32
12 8½	63.80	50.35	2.817	99.0	1.96	140	2.80	172	3.42

(TABLE II CONTINUED)

Flume diam.	Stone, s = 0.0004 Q	0.0004 V	0.0005 Q	0.0005 V	0.0006 Q	0.0006 V	0.0008 Q	0.0008 V	0.001 Q	0.001 V
1 0	0.19	0.63	0.22	0.70	0.24	0.77	0.28	0.91	0.31	1.01
1 3½	0.38	0.76	0.42	0.84	0.47	0.94	0.54	1.08	0.61	1.22
1 11	1.20	1.06	1.34	1.19	1.48	1.31	1.71	1.51	1.90	1.68
2 6½	2.65	1.32	2.97	1.47	3.28	1.63	3.79	1.88	4.23	2.11
3 2½	4.75	1.52	5.31	1.70	5.87	1.87	6.77	2.16	7.58	2.42
3 10	7.98	1.76	8.90	1.96	9.83	2.17	11.4	2.51	12.7	2.80
4 5½	11.9	1.93	13.3	2.15	14.8	2.40	17.0	2.76	19.1	3.09
5 1	17.0	2.11	19.0	2.36	20.9	2.61	24.2	3.01	27.0	3.36
5 8½	23.3	2.29	26.0	2.56	28.8	2.82	33.2	3.26	37.1	3.65
6 4½	31.2	2.49	34.9	2.79	28.6	3.08	44.6	3.56	49.8	3.98
7 0	40.7	2.68	45.5	3.00	50.2	3.30	58.0	3.82	54.8	4.27
7 7½	51.0	2.82	57.2	3.15	62.8	3.47	72.6	4.01	81.5	4.49
8 4	64.5	3.00	72.3	3.35	80.0	3.71	92.6	4.30	103	4.78
8 11	77.2	3.13	86.4	3.50	95.8	3.88	110	4.45	124	5.02
9 6½	93.0	3.28	104	3.68	115	4.07	133	4.68	149	5.25
10 2	109	3.38	122	3.79	135	4.21	156	4.85	174	5.43
10 10	130	3.57	145	3.98	160	4.40	185	5.07	207	5.68
11 5½	150	3.66	167	4.10	185	4.52	213	5.22	238	5.83
12 1	174	3.83	194	4.28	213	4.68	246	5.40	275	6.04
12 8½	200	3.96	223	4.44	242	4.80	280	5.55	314	6.25

(TABLE II CONTAINED)

Flume diam.	Slope, s = 0.0012 Q	0.0012 V	0.0015 Q	0.0015 V	0.002 Q	0.002 V	0.003 Q	0.003 V	0.004 Q	0.004 V
1 0	0.34	1.10	0.38	1.26	0.45	1.44	0.54	1.76	0.63	2.03
1 3½	0.66	1.32	0.74	1.49	0.86	1.72	1.05	2.11	1.22	2.44
1 11	2.09	1.85	2.34	2.07	2.70	2.39	3.31	2.93	3.82	3.38
2 6½	4.68	2.33	5.23	2.60	6.05	3.01	7.40	3.68	8.58	4.26
3 2½	8.32	2.68	9.32	2.97	10.7	3.41	13.1	4.18	15.2	4.83
3 10	13.9	3.07	15.5	3.42	17.9	3.95	21.9	4.84	25.3	5.60
4 5½	21.0	3.41	23.5	3.81	27.4	4.43	33.6	5.44	38.8	6.30
5 1	29.7	3.70	33.2	4.12	38.3	4.76	47.0	5.85	54.3	6.75
5 8½	40.6	4.00	45.5	4.47	52.5	5.16	64.2	6.32	74.2	7.28
6 4½	54.5	4.35	60.8	4.85	70.2	5.60	85.8	6.85	99.2	7.87
7 0	71.0	4.68	79.8	5.25	91.6	6.03	112	7.38	130	8.53
7 7½	89.3	4.95	99.7	5.51	115	6.38	142	7.83	163	9.02
8 4	113	5.22	126	5.85	146	6.76	178	8.25	206	9.60
8 11	136	5.50	152	6.15	174	7.05	214	8.67	247	10.0
9 6½	163	5.75	182	6.43	211	7.43	258	9.06	297	10.5
10 2	191	5.94	213	6.64	247	7.68	302	9.38	349	10.8
10 10	226	6.21	252	6.95	292	8.05	358	9.87	413	11.4
11 5½	261	6.40	292	7.16	338	8.28	414	10.1	478	11.7
12 1	301	6.62	336	7.42	388	8.53	475	10.4	549	12.0
12 8½	344	6.85	386	7.66	445	8.85	545	10.8	632	12.6

(TABLE II CONTINUED)

Flume diam.	Slope, s = 0.005 Q	0.005 V	0.006 Q	0.006 V	0.008 Q	0.008 V	0.010 Q	0.010 V
1 0	0.71	2.28	0.78	2.50	0.90	2.89	1.00	3.23
1 3½	1.37	2.74	1.50	3.00	1.73	3.46	1.93	3.86
1 11	4.31	3.81	4.72	4.17	5.45	4.82	6.10	5.38
2 6½	9.65	4.80	10.6	5.25	12.2	6.05	13.6	6.77
3 2½	17.1	5.45	18.7	5.97	21.7	6.90	24.2	7.70
3 10	28.7	6.32	31.4	6.93	36.3	8.05	40.5	8.98
4 5½	43.2	7.02	47.5	7.70	54.7	8.86	61.2	9.88
5 1	61.0	7.58	66.8	8.35	77.2	9.60	86.0	10.7
5 8½	84.0	8.23	91.7	9.02	106	10.4	118	11.6
6 4½	112	8.90	123	9.75	142	11.3	158	12.6
7 0	146	9.64	160	10.6	185	12.2	207	13.6
7 7½	183	10.1	200	11.1	231	12.7	259	14.3
8 4	232	10.7	254	11.7	293	13.6	328	15.2
8 11	277	11.2	302	12.2	350	14.2	391	15.8
9 6½	334	11.8	366	13.0	423	14.9	473	16.7
10 2	393	12.2	430	13.4	496	15.4	555	17.3
10 10	464	12.7	509	14.0	588	16.2	657	18.1
11 5½	537	13.1	590	14.4	681	16.6	760	18.6
12 1	618	13.6	678	14.9	782	17.2	874	19.2
12 8½	708	14.0	776	15.4	897	17.8	1000	19.9

has been noted in the table alongside the corresponding discharge.

It is plainly evident that increasing the freeboard reduces the discharge very rapidly and as a certain amount of freeboard is always necessary it is highly desirable that attention be given in the future to producing a flume of such cross-section that the material will be more economically distributed.

Hints for Increasing the Accuracy of Survey Fieldwork

By Robert S. Beard*

Precision in Transit Setups—The question of the permissible error in setting up a transit over a point often occurs to the transitman's mind, and so the following facts may be of some general interest.

Paul Mast, an engineer in Berlin, Germany, pointed

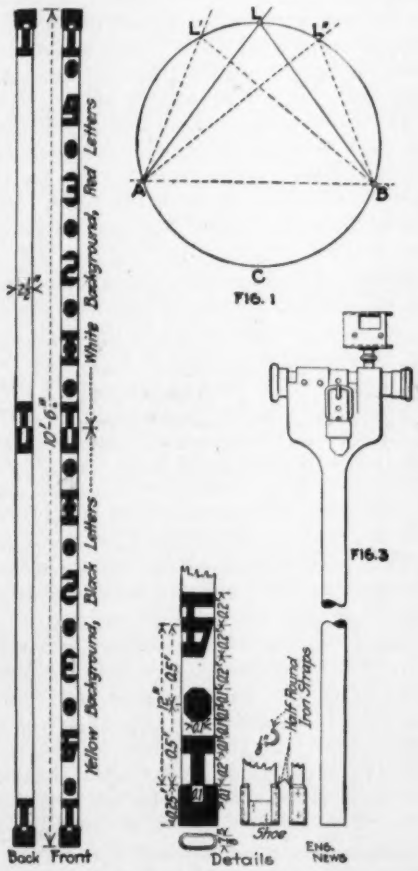


FIG. 1

FIG. 3

out to the writer some time ago, that if the transit is set up over any point as V' or V'' in the arc AVB (Fig. 1) of the circle passing through the three points AVB, the angle measured by the transit between A and B will be equal to the angle AVB in all cases, since all of these angles intercept and are measured by one-half of the arc ACB. It is therefore much more important to keep the transit on the circumference of the circumscribing circle than on the radius through the angle point.

*Assistant Engineer, Board of Public Works, Department of Engineering, Kansas City, Mo.

The writer has computed the accompanying table to show the radial offset, under different conditions, corresponding to an error of ½′ in the angle when the two sights are of equal length. It can be seen from the table that the transit may be off center 0.007 ft., or about the diameter of the head of the tack, for each 100 ft. of distance to the nearest rod.

TABLE OF RADIAL OFFSETS CORRESPONDING TO AN ANGULAR ERROR OF ½′, IN DECIMALS OF 1 FT.

	Length of equal tangents			
Deflection angles	100-ft.	500-ft.	1000-ft.	3000-ft.
0°	0.0073	0.036	0.07272	0.218
10°	0.0073	0.036	0.07300	0.219
20°	0.0074	0.037	0.07384	0.222
30°	0.0075	0.038	0.07528	0.226
45°	0.0079	0.039	0.07871	0.236
60°	0.0084	0.042	0.08397	0.252
90°	0.0103	0.051	0.10284	0.309
120°	0.0145	0.073	0.14543	*0.436

*Inside offset 0.4363, outside 0.4364.

Determination of the H. I. of the Transit—The following one-man method is more accurate than the customary two-man methods used to determine the H. I. in stadia work, plunging grades, or other transit work when the instrument is set up over the benchmark. It requires that the transitman carry a small steel tape marked to 0.01 ft.; and it is necessary to determine beforehand the height K of the line of collimation above the plumb-bob hook.

The height K can be determined as follows: Set up the instrument anywhere, near a stake, and determine the elevation of the stake from some convenient benchmark. Next set up over the stake and determine the H. I. from the same benchmark. Catch the loop at the end of the tape over the plumb-bob hook and measure the distance down to the top of the stake. Add this tape measurement to the elevation of the stake. The difference between the H. I. and this sum is the value of K.

After K has once been determined, to find the H. I. for any setup, get the tape measurement from the plumb-bob hook to the top of the stake as above. The sum of the elevation of the stake, this tape measurement, and K, is the H. I.

Setting Grade Stakes—George S. Russell, who was at one time field engineer in the Kansas City (Mo.) city engineering department, has shown the writer the following method of setting grade stakes: First, the axeman holds the stake upside down on the point where it is to be driven, then with the help of the rod and transit he marks the grade point on the stake. After this he sets the stake right side up and drives it almost to grade; a little leeway is allowed for a final check from the instrument. With this method one rodman can keep two axemen busy setting stakes.

Locke Hand-Level Fieldwork

The writer has taken a considerable amount of fairly accurate railroad topography and has done a lot of cross-sectioning with the Locke hand-level; and he believes that the methods that he has worked out are worth while calling attention to. Fig. 2 is a plan of the 10½-ft. topography rod, and Fig. 3 is a sketch showing a 5¼-ft. stick for mounting a Locke hand-level.

The topography rod is 10 ft. 6 in. long, 2½ in. wide and ⅞ in. thick; the sides are trimmed half round and there is an iron shoe on each end. One-half of the rod is painted white with the numbers in red and the other half yellow with the numbers in black.

The center of each numeral is at the corresponding

number of feet measured from the center of the rod. The numerals on the lower half of the rod are inverted. Each numeral is 0.4 ft. high and each half-foot mark 0.2 ft. high. This arrangement divides the rod into 0.2-ft. spaces.

The style of figure shown has been taken from the Fish stadia rod;* each figure is made up of five parts 0.08 ft. wide, or 0.10 for Locke hand-level purposes. Each half of the zero and the inner division of each 5-ft. mark is 0.3 ft. high, and is subdivided into parts 0.2 ft. and 0.1 ft. high. The zero and 5-ft. marks are also painted on the back of the rod.

The Locke level stick is cut out of a piece of oak 4¼ x1¼ in.x5 ft. 3 in. long. A half-round groove is cut into one end to fit the Locke level; and from 2¼ to 5 in. from this end the wood is trimmed down to a 1¼-in. round stick, the lower end of which is brass shod. There are shallow cuts running around the rod at the foot marks, as measured from the brass-shod end, and also a cut at the 2.35-ft. or the half-gage point.

The Locke level fits snugly into the half-round groove in the top end of the stick and is held there by means of a leather strap. An angle mirror is mounted over the level on a ⅛-in. thick brass stirrup, the loop of the stirrup being just large enough to allow the eyepiece end of the level to pass through it.

The topography is sketched in a standard cross-section field-book. Two elastic bands hold the book open at the right place and keep the leaves from fluttering in the wind. A rubber eraser is tied to a double string which is looped through a hole punched in the back cover of the book. A 100-ft. steel tape and two sets of chain pins distinguished by pieces of red and orange cloth tied in the rings, or else painted in different colors, complete the outfit.

FIELDWORK—The bottom of the rod when it can be read at all is usually hidden for the first tenth or two behind grass, leaf mold, a ground furrow, or some other obstacle; and for this reason the 5-ft. points of the topography rod have been raised 3 in. above the ground, and the level stick has been lengthened to 5 ft. 3 in.

When the zero mark is at the center of the rod, the rod reading is the actual difference in elevation of the two points occupied. Two points are gained by inverting the numerals on the lower half of the rod; first, the rod is never upside down, and one is less likely to read the tenths in the wrong direction from the foot marks with this arrangement.

It was the intention to mark both sides of the rod alike, but at the suggestion of L. A. Riley, at the time engineer-in-charge of the Lehigh & Hudson River Ry., only the zero and 5-ft. points were markd on the back of the rod, thus eliminating the danger of confusing these marks with others at a distance. This makes a strong, legible rod which can be easily carried and swung around in one hand.

The angle mirror consists essentially of two vertical mirrors set at 45° to each other, and therefore the image as reflected in the angle mirror appears in a line at 90° to its actual direction from the point. This is in accordance with the optical law, that the line of a doubly reflected ray of light makes an angle with its line of incidence of twice the angle between the two reflecting surfaces. The right angle of the angle mirror may be depended upon to within 1 ft. in 300 ft. There are total refracting prisms which serve the same purpose.

We used 100-ft., $\frac{5}{16}$-in. wide, Chicago steel tapes for topography. They are preferable to the 50-ft. metallic tapes because, although they cost three times as much, they will outwear half a dozen metallic tapes; they require one less measurement in 100 ft., and they drag along the line and are not blown out of reach by the wind. They are better than $\frac{3}{16}$-in. steel tapes because the graduations are more legible; they do not stretch, are more easily distinguished when lying in the grass, and can be done up with less trouble. It is a good thing to leave the half-gage point marked on tapes used in railroad-location work. One set of pins is used to mark stations and the other set to mark contours.

The topography parties that the writer has worked in have usually consisted of three members; the topographer, who has charge of the party, keeps the notebook and does the back chainman's work; the rodman, who carries the rod, front end of the chain, and both sets of pins, one set in each hip pocket, and the Locke levelman, who uses the hand-level, pulls up the pins marking the contours, and, in case he arrives at the 100-ft. point ahead of the topographer, measures the distance to the first contour beyond. When the contour points are marked with pins, it is not necessary for the rodman to wait for the levelman to catch his point. The rod is kept ahead because it takes less time to move it than the level.

The rodman determines the cross-section lines by picking out well defined markers in line with the double reflection of the center-line stakes in the angle mirror. It does not require any more time to pick out a right angle with the angle mirror than by eye, and it makes all of the difference between the feeling of doing careful work instead of slipshod work. Topographers will readily admit that it is a common thing to be 15 to 20 ft. off line at a distance of 300 ft. from the stake. This can amount to a considerable error in elevation in side-hill work. Then, it is some satisfaction to have roads and other long straight lines come out straight on the map.

The writer has also used this same hand-level and 5-ft. stick for cross-section work on railroad construction by working from center-line elevations established with the level. We used a common level-rod for this work and carried an extra 5-ft. stick along to help pick out the grade points. At the station on the cut side of the grade point, the eye is held at the point on the level stick, which is 5 ft. above grade, and a sight is taken at the target of the level-rod which is also set 5 ft. above grade and is located at the first station on the fill side.

For example, the cut at Sta. 551 is at 2.2 ft., and the fill at Sta. 552 is 3.4 ft. The eye is held at 2.8 ft. on the level stick and the target of the level-rod is set at 8.4 ft. The man who keeps the notes then runs the extra 5-ft. stick back and forth along the line. At the grade point the top of the stick coincides with the line of sight. This trick was shown to me by L. C. Mayer, chief engineer of the York Railway Co., York, Penn.

If the government is going to re-cross-section the different railroad lines in making its physical valuations, an outfit of this kind equipped with a 15-ft. rod would do good service, since relative elevations from the subgrade at different distances from the center line of track are all that would be required.

*Described in "Engineering News," Oct. 7, 1909, p. 387.

NOTES

Standard Caps and Rings for Protecting Wooden Pile Heads in Driving—Henry Hess, Witherspoon Bldg., Philadelphia, Penn., writes us that he is in search of information regarding existing practice in the use of caps and rings for protecting the heads of wooden piles while being driven, for use in compiling standards for such work; but has found difficulty in securing reliable data. He will be glad to receive from any of the readers of "Engineering News" blueprints showing the caps and rings used in their own practice in pile driving.

A **Simple Pocket-Level and Sighting-Box** for use in such work as surfacing track, laying sewer or drain pipe, setting sidewalk grades, cutting off piles, etc., is shown in the accompanying cut. It consists of an aluminum box about 2½ in. square and 6 in. long, containing a mirror set at an angle of 45°, and having two slips of glass across it, one slip in the top of the box and the other forming the end. The former has a white line marked upon it, while the other has a red line, as shown. At the rear end of the top is a level bubble,

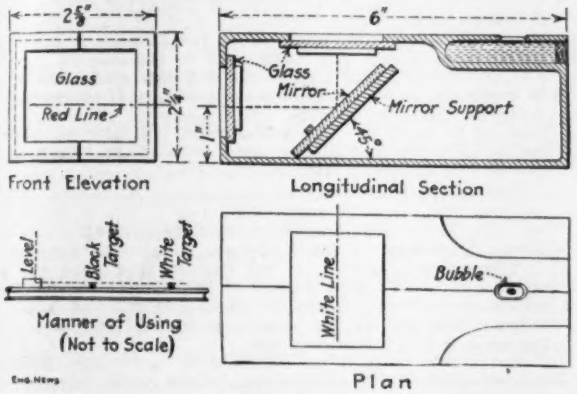


FIG. 1. POCKET LEVEL AND SIGHTING BOX
(J. G. Home, St. Augustine, Fla.; Inventor.)

so that the device may be used either to give a level or to give a desired grade.

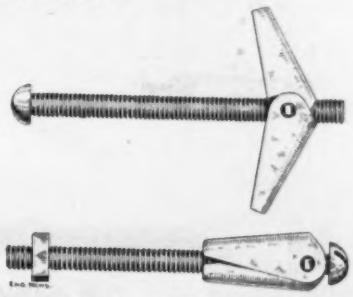
In sighting, the observer, looking down on the top, brings the two (red and white) lines in one, and then a distant target is brought into the same line. An intermediate target is set at different points and adjusted to bring it in line with the sighting box and the distant target. In surfacing track the box is placed on the rail, giving a sighting line 1 in. above the rail, and two small angle-shaped targets are used, 1 in. in height. One is painted white and the other is black. The white target is set at any desired distance (not over 300 ft.) and the black target set at different intermediate points. The rail is adjusted so as to bring its top into the sighting line between the box and the distant target.

FIG. 2. SIGHTING BOX AND TARGETS

This device is the invention of J. G. Home, supervisor of water-supply, Florida East Coast Ry., St. Augustine, Fla. It has been used on track and sewer work, and also in trestle construction to give the line for cutting off the piles to receive the caps.

A New Anchor-Bolt Fastening of the toggle type is shown in the accompanying cut. The toggle arms fold down to allow the bolt to be inserted in the hole, as shown at the top, and when the head has cleared the hole a spring throws the arms out, as shown at the bottom of the cut, the spread being about 2 in. The arms are pivoted to trunnions on the nut and when open they engage the thread or the bolt head, thus giving a grip in addition to that of the nut.

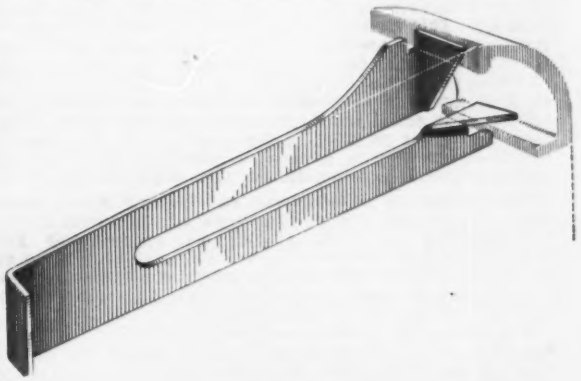
With the toggle arms folded the bolt will pass through a ⅞-in. hole, and as the length of head is then about 1 in. the bolt will work in hollow tile with a hollow of only 1⅛ in. The device can be used as a screw, or as a bolt with a nut. In the former case, as shown in the lower view, the open toggle engages the thread and serves as an auxiliary nut. In the latter case, as shown in the upper view, the head of the bolt engages the ends of the open toggle. This device is being introduced by the Paine Co., 1316 Corn Exchange Bank Building, Chicago.



ANCHOR BOLT WITH TOGGLE-JOINT ANCHOR

A Securely Anchored Concrete-Curb Guard has recently been produced. The efficacy of a curb guard is largely measured by its immovability upon the concrete. If it is not securely anchored, the blows of the wagon wheels, etc., will cause the concrete to crumble or crack.

The purpose of the clip anchor, shown in position in the accompanying cut, is to position and support the guard in the forms while the concrete is being placed, and to hold the guard rigid after the curb is laid. The whole is called the "Clip-Bar" Galvanized Curb-Guard, and is manufactured by the Clip-Bar Manufacturing Co., of Philadelphia, Penn.



THE CLIP-BAR GALVANIZED CURB GUARD WITH CLIP ANCHOR

The Calumet Drainage Channel of the Sanitary District of Chicago (which will extend from the Calumet River to the main drainage channel) has developed some trouble in the excavation on section No. 4. According to a statement by the chief engineer of the Sanitary District, the material on this section proved to be a poor quality of peat which, when the canal was being excavated, would continue to break and cave. The spoil area next to the canal would not hold the weight of the superimposed material coming from the excavation, and additional spoil area had to be bought and the method of disposal of the excavated material changed.

The material between this new spoil area and the channel was hard and not of a peaty nature, and it was hoped that the material back of this would prove strong enough to sustain the weight of the spoil. But parts of it are similar to the softer material, and the result has been expensive for the contractor in the removing and disposing of the spoil. A trestle was first built, but the swelling of the ground so distorted the trestle that it had to be abandoned. The contractor then changed from dump cars to derrick cars and has unloaded his cars by means of a derrick.

Erecting Arch Trusses by Tripping Up—The operations in constructing the new drill hall of the University of Illinois were described in a general way in our issue of December 11th, 1913. Some of the erection features of the upending method used in setting the large arch trusses are illustrated further by the two views herewith. The half arches were erected flat on the ground, and were then lifted into a vertical plane with end and center hinges, however,

FIG. 1. RAISING A HALF-ARCH TO VERTICAL POSITION
(Braced pair of arches at right.)

FIG. 2. THE FIRST PAIR OF ARCHES SET AND GUYED, READY TO PUT IN BRACING

still on the ground. Fig. 1 shows this operation, and the half arch happens to be foreshortened in such a way as to show clearly if it is warped or bent. It will be seen that the structure shows no deflection or warping. Fig. 2 shows an earlier view, erecting the first pair of arches (in Fig. 1 the completed tower or first pair of arches is seen to the right). The two arches of the tower in Fig. 2 are separately guyed until the bracing and purlins can be put in. The bracing on the far side between the vertical ends of the arches has just been set. This view gives a very good idea of the length and slenderness of these trusses as erection parts. At the same time, it shows each of the two trusses to be perfectly in plane.

Referring again to Fig. 1, the completed tower at the right is shown in self-supporting condition, nominally fully braced. The end bracing and some of the top-chord erection rods are in, but on much of the length of the arch only the stiffness of the purlin connections holds the arches in place. Apparently this condition did not lead to any trouble.

An Instrument for Reducing and Plotting Stadia Notes—The accompanying illustration shows an instrument invented and patented by C. K. Averill, 407 Philipsburgh Bldg., Yonkers, N. Y., designed to save labor in plotting notes of a stadia survey. The instrument consists of a 10-in. protractor, a 10-in. straight-edge, graduated to 0.1 in., a plotting scale and the elements of a stadia diagram.

The stadiagraph is based on the well known formulas: $d = Kr \cos^2 v$, where d the distance, K the stadia interval (assumed to be 100), r the rod reading and v the vertical angle; and $h = \frac{1}{2} Kr \sin 2v$, where h is the difference in elevation. The instrumental constant (f + c), must be added for large-scale maps.

The pivoted scale FF is the scale of the map and can be changed. This scale is used to determine the horizontal distance from the transit station to the stadia point by setting its graduated edge on the recorded vertical angle reading on the arc scale A, and moving the sliding scale HH until its graduated edge intersects the edge of the pivoted scale FF at the recorded rod reading. The intersection of HH and the straight-edge is the point required. No great accuracy is required in setting the graduated edge of the pivoted scale on the arc scale A as the square of the cosines varies but little for a few minutes of angle.

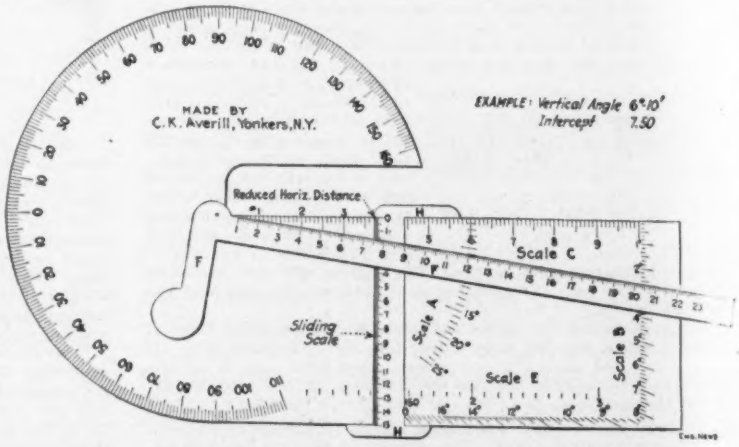
The graduations of the sliding scale HH are determined by the scale of B, which is an assumed scale based on the sines of double the recorded vertical angles, solving the triangle for $h = \frac{1}{2} Kr \sin 2 v$. Placing the graduated edge of HH on the rod reading on the straight-edge scale, the intersection of the graduated edge of FF and HH will give the difference in elevation on HH for any recorded vertical angle setting of FF on the scale B. For vertical angles greater than 20°, scale D is used with a special scale for rod intercepts E.

The inventor claims an accuracy in plotting horizontal distances equal to the case where the distance is first computed by slide-rule and transferred to the map by plotting, and while this would answer for ordinary stadia side shots, it would not seem to eliminate the necessity of computing the traverse lines for closure. The accuracy of elevation is claimed to be ½ ft. The stadiagraph will plot all vertical angles up to 30° and all elevations up to 130 ft. The plotting length for horizontal distances is 10 in.

Extracting Fifth Root by Slide Rule—The method of extracting fifth root by slide rule given in our issue of Dec. 25, 1913, brings out another method from Prof. J. Maughs Brown, University of South Dakota, Vermillion. He says.

The method outlined in the "News" is a good one and applicable to any slide rule, but the correct result is obtained only after a series of approximations and would be worth while only on the Mannheim type of rule where the log-scale is inconvenient to use.

For approximate values of the fifth root I have used the following, which is accurate enough for some computations: Take the fourth root and the sixth root of the number whose fifth root is to be found, and to the sixth root add 34% of the difference between the two. The fifth root is found at the first trial. The method is applicable only to slide rules having both square-root and cube-root scales, on which the fourth and sixth roots are very quickly obtained.



STADIAGRAPH INVENTED BY C. K. AVERILL FOR PLOTTING STADIA NOTES.
(¼ actual size.)

For any slide rule of the duplex type the use of the log-scale is much quicker than either the method above or the method given before.

We might add that finding cube root is easy enough on the simple Manheim scales, so that Prof. Brown need not limit his method to rules having the special cube-root scale.

Editorials

The Failure of the Stony River Dam

The attention of the public and of the engineering profession is directed anew to the subject of safe dam design by the news, widely published in the daily journals last week, of the failure of the recently completed Stony River Dam in West Virginia.

The failure of this dam occurred only a few hours after last week's issue of ENGINEERING NEWS went to press. We are very glad to be able to present to our readers in this issue a complete detailed account of the construction of the dam, with full illustrations, written especially for us by the engineer in charge of the work. This article, supplemented by reports from a member of the editorial staff of ENGINEERING NEWS who reached the dam site as soon after the disaster as the transportation facilities would permit, will be studied with interest, we are sure, by engineers everywhere who are interested in the problems of safe dam construction.

From the reports given by our representative, it will be seen that the newspaper accounts of last week greatly exaggerated the damage done by the failure. No lives were lost, nor even put in danger. The amount of property damage is little, other than that required to replace half a dozen bays of the dam which failed. The harm done by the published sensational accounts of the disaster, however, is not so easy to measure. A thousand persons will read and remember the first exaggerated story of destruction, where one will read and remember the later accounts which showed the comparatively small importance of the disaster. The harm done to public confidence in the safety of dams is serious.

The account of the failure given elsewhere in this issue makes it clear that the trouble lay in the foundation. This has been the case, indeed, with most of the notable dam failures that have occurred in recent years. That this was the weakest point of the structure might, indeed, be surmised from reading the account in this issue of the construction and the difficulties met with, although the article describing the work was written while the dam was intact. The failure, however, cannot be laid to the treacherous character of the cutoff excavation where the cutoff reached rock, but to the fact that a length of 200 ft. of the dam was practically without a cutoff wall.

The last great dam break, that at Austin, Penn., two years ago, was also a foundation failure, in clay and shale soil. Comparisons between Austin and Stony River will therefore be made. However, essential distinctions between the two cases must be recognized carefully, and among these the following:

At Austin, the owners did everything to economize in the cost of the dam, even to the extent of nullifying the engineer's authority; the blame for the failure is essentially theirs. On the other hand, the Lukes in building the Stony River Dam aimed at first-class construction, with no desire to save at the expense of quality; if the engineer's judgment erred, the fault is his.

The Compensation of Engineers

Elsewhere in this issue we present the report of the Special Committee of the American Society of Civil Engineers appointed a year ago to investigate the conditions of employment and compensation of civil engineers throughout the country. The statistics collected by this committee deserve, and will without doubt receive, very careful study by the profession as a whole, including especially the younger members of the profession and the students and others who aspire to become engineers and who have a legitimate desire to know what they may reasonably look forward to in the way of an income if they attain success in their profession.

If the figures collected by the committee and the average earnings which they report could be taken as representing the average earnings of civil engineers, then the civil engineering profession might well be congratulated on its showing of financial prosperity. Of course, it could not be claimed that the average compensation shown by these statistics is excessive; nobody claims or supposes that civil engineers as a class are getting rich out of their professional work. But if the average civil engineer at the end of five years' experience is earning $2000 a year, increasing at the end of 11 years to $3000 a year, and to $4000 at the end of 15 years and $5000 at the end of 21 years—if the average civil engineer gains this much return from his professional work, then he has small cause to complain. There can be little doubt that he is doing better than the average physician or lawyer, to say nothing of clergymen and teachers.

But are these average earnings thus compiled really the average earnings of the civil engineering profession? We do not believe that these earnings by any means represent the average compensation of engineers. Rather, they show the average earnings of those who achieve exceptional success in the profession; and that changes their whole significance.

In the first place the membership of the American Society of Civil Engineers represents the men who have succeeded in the profession. The initiation fees, annual dues and other expenses connected with membership in the Society automatically tend to limit membership at the outset to those members of the profession who can afford to spare from their income the amount involved. In the second place, the professional requirements for membership distinctly limit the privilege to those who are or have been "in responsible charge of work," as the Society's constitution puts it. This requirement is generally so construed by the Board which passes upon applicants that in order to attain full membership in the Society a man must hold or have held a position in engineering work of considerable responsibility.

It would be interesting to inquire what percentage of the civil engineers of the United States hold membership of one grade or another in the American Society of Civil Engineers. Of course, an answer to this question brings

up the disputed point as to what a civil engineer is. Anyone with wide acquaintance among those engaged in civil engineering work, however, is well aware that only a small percentage of them hold membership in the national Society. There is at the present time, and has been for some years past, an annual output of graduates from the schools of civil engineering in the United States amounting probably to 4000 to 6000 per annum. Besides this annual increment, there must be included the large number of students who take a partial course in the engineering schools and leave without graduation to take up engineering work. There is also the considerable number of men who work into engineering without the advantage of an engineering school course, adding to their practical experience on actual work such knowledge as they can gain from the correspondence schools' aid in home study.

What the total number of civil engineers in the United States may be at the present time, can only be guessed, especially since, as noted above, there is no possibility of drawing a hard and fast line as to who is and who is not a civil engineer. It is probable, however, that those engaged in civil engineering work of one sort or another, not including, of course, those engaged merely as laborers or skilled workmen, number not less than 100,000 at the present time.

If we may assume these figures to be approximately correct, then not one in a dozen of the civil engineers in the United States are connected with the American Society of Civil Engineers. A large proportion of those who are members of the Society have achieved some distinction in the profession and many hold positions involving large responsibility and high compensation. A very considerable proportion of the members of the Society, also, are carrying on engineering not as a profession, so that their earnings are measured by fees or salaries, but as a business. Their work is just as truly civil engineering as that of the man who is in private practice as a consultant, or who holds a position as chief engineer on a salary, but the financial returns, provided a large success is attained, may be far greater.

In this connection it must be remembered that the averages on which the figures reported by the American Society committee are based were made up from returns received from only a little over half of the Society's members. Can these figures be taken, therefore, as typical of the earnings of the Society members taken as a whole? We do not believe this is the case. One needs only the slightest knowledge of human nature to realize that the members who fail to make returns to such an inquiry as was sent out by the committee will be in general those whose earnings are of such modest proportions that they are unwilling to make them known to anyone, especially to their fellow members in the profession. This applies especially to the men of considerable years and experience. The young man only a few years out of college has less hesitancy in frankly stating the amount of his salary.

On the opposite side, human nature being what it is, the man who has achieved a distinguished success in his profession, financially as well as otherwise, in nine cases out of ten, has no objection whatever to letting the fact be known. He has to fill out an income-tax schedule about this time anyway, and there is no reason why he should not answer the query sent out by a committee of the engineering society to which he belongs.

Still further, in analyzing the reported average annual earnings as summarized by the committee, there must be taken into consideration the influence upon these averages of the very large earnings of certain men in the profession whom we may assume to be included in this list which the committee has averaged. How large these earnings are is indicated to some extent by the line on the committee's diagram showing the maximum rate of compensation attained by those who reported, running up in some isolated cases above $150,000 per annum. It may be said that such enormous earnings are too few to affect the average much; but on the other hand, there is a very considerable sprinkling of members in the American Society of Civil Engineers whose income from engineering work averages between $20,000 and $60,000 per annum. If the earnings of this class were deducted from the totals on which the American Society committee's averages are based, it is probable that these averages would be materially reduced from their present figures.

We present the above analysis of the committee's statistics, not by any means to criticize the committee's work. It has rendered a valuable and important service in obtaining this information and spreading it before the profession. Our purpose has been so to analyze these statistics as to determine what is their real significance.

There seems no room for doubt from the above analysis that the figures of annual average earnings of the civil engineering profession given in the committee's report are much in excess of the actual average earnings of the average civil engineer. Indeed it requires very little knowledge of the usual scale of engineering salaries to appreciate that this must be the case.

As to what, if anything, can be done by the profession to better the conditions of employment and the compensation of civil engineers throughout the country, that is another story; and it is within the possibilities that the American Society committee may report further conclusions upon this point.

Possibly it may be said that the committee's statistics show such a satisfactory scale of prosperity prevailing among the members of the Society that there is no need for the Society or its committee to give further consideration to the matter. This seems to us, however, a limited view of the duties and responsibilities of the American Society of Civil Engineers. As the leading national organization of the country devoted to the interests of the civil engineering profession, its duty is not merely toward its own membership but toward all those engaged in civil engineering work. If there are conditions which can be changed by the profession itself which will better the conditions of employment and increase the compensation of the rank and file of the engineering profession, then the Society has a responsibility to see that these conditions are determined and carried out.

Meanwhile, we hope the analysis we have presented above may at least serve to prevent the misuse of the figures which the American Society committee has made public. It is farthest from our desire in any way to discourage the youth who desires to fit himself for the civil engineering profession with a clear understanding of what lies before him; but we believe it to be the duty of engineers and particularly of engineering educators to discourage boys from taking up engineering who are led to do so merely by the stories they have read concerning the great earnings of distinguished engineers, who have no understanding whatever of the difficulties and dis-

couragements which lie before them, and who are, in a large proportion of cases, so little fitted to win success in engineering work that they are doomed beforehand to failure and disappointment. The overcrowding of the profession in its lower ranks by men of this class is one of the handicaps under which the profession labors.

The Consolidation of the Harvard Engineering Schools and the Massachusetts Institute of Technology

The announcement made in our last week's issue that a plan of coöperation had been agreed upon between Harvard University and the Massachusetts Institute of Technology is the most important news with reference to engineering education that has appeared in a long time.

For a dozen years at least it has been evident that as a practical business proposition it was unwise to continue to carry on independently these two great institutions, located side by side, drawing their students from practically the same territory, and conducted upon very similar lines.

It is true that Harvard has in recent years attempted to differentiate itself from its rival as well as from other engineering schools devoted chiefly to undergraduate work, by laying the emphasis entirely on graduate instruction. The attempt has not been notably successful, however, from an educational point of view. The number of students in the Harvard graduate school of engineering has been absurdly small in proportion to the great expense involved in carrying it on.

As many of our readers will recall, a previous attempt to consolidate the two instutions, made in 1905, resulted in failure because of the opposition of a large part of the Institute's Alumni who feared that the Institute was in some way to lose its identity.

But in the agreement framed in 1905 as well as in the new agreement just completed, the plan is to have the Harvard Schools absorbed by the Institute. It is the latter which is to retain its identity unchanged and its entire organization. It is the old Lawrence Scientific School and newer graduate engineering schools of Harvard, which are to be definitely abandoned. This much deserves to be said here in justice to the far-seeing leaders in education who worked out the plan of union which failed eight years ago.

Of course, in planning the merger it has been necessary to lay emphasis on the permanent, continuing existence of the two institutions and to call it a plan for cooperation instead of consolidation. This was wise not only to steer clear of popular opposition, but to comply with the legal requirements under which various funds are held by the two institutions.

Reading between the lines of the agreement, however, it is clear that the ultimate result aimed at is the establishment of the Institute of Technology on a permanent basis as an independent educational institution, but with the authorities of Harvard University directly interested in its maintenance and development, and contributing very heavily to its financial support.

It is in the highest degree creditable to President Lowell, of Harvard, and his associates that they have taken this broadminded view of their duty and opportunity with reference to engineering education instead of continuing longer the effort, never very successful, to carry on an engineering school as a part of Harvard University.

Emphasis may well be laid too on the great acquisition which the Institute of Technology makes by this consolidation. We may well place among the first of these acquisitions the present teaching staff in the Harvard graduate engineering school, a set of men on which any engineering school in the country would place a high valuation. From the financial side, the Institute is to receive the net income of all funds belonging to Harvard University and heretofore credited to the Lawrence Scientific School and in addition not less than three-fifths of the income from the Gordon McKay endowment. This was a bequest made to Harvard University by the wealthy inventor of shoe machinery, and under the terms of the bequest the major part of the endowment is to go on accumulating interest until a very large capital sum is reached. The present income of the fund is, we believe, something like $60,000 to $70,000 a year.

A valuable provision of the bequest is that it is to be assigned to current expenses instead of to the erection of buildings, exactly the contrary from the restrictions imposed by most would-be benefactors of educational institutions.

The Institute of Technology, like most other educational institutions, greatly needs a larger income so that more adequate salaries may be paid to its teaching staff. The large addition to its income which this arrangement with Harvard will provide will go a long way toward enabling the Institute to bring and keep together a teaching staff of the right quality to properly use the magnificent buildings which are to be erected for its occupancy.

A Proper Plan for Promoting Publicity

Every one has heard the chronic complaint by enginers that their work is not properly appreciated and understood by the general public. Particularly is this lack of appreciation felt when it is measured in terms of dollars and cents. But lack of appreciation in other respects is also felt. An engineer of ability, experience and success in his profession has a natural ambition to be considered as large a factor in the life of his city as is the lawyer, or the merchant, or the banker, or the physician.

In discussing this and kindred questions in these columns, we have often maintained that if and where the engineering profession is not satisfied with its position and wishes to better its standing with the public, it should rely upon its own exertions, put forth with the same intelligence and good judgment that are devoted to the accomplishment of technical tasks.

It is idle to dream that through some fortuitous combination of circumstances the public will suddenly awake to find what important service the engineering profession is rendering. The public will only become thus educated when proper means are taken to bring about such education.

There is an important lesson for the engineering profession, we believe, in a paper printed elsewhere in this issue by C. E. Drayer, describing the publicity work which has been carried on for more than a year now by the Cleveland Engineering Society under Mr. Drayer's

direction. It was found that the newspapers of Cleveland were just as ready to give space for descriptions of the important work which Cleveland's engineers are doing as to sensational achievements in the sporting field or to crimes in the underworld, provided only that the story of what engineers are doing was told in a way which would interest the reader.

It is true that engineers are comparatively rare who have the faculty of writing what newspaper men call "a story" on a piece of engineering work and holding the interest of the non-technical reader. It is, nevertheless, possible to find such men, and the Cleveland Engineering Society was fortunate in placing such a man in the Chairmanship of its Publicity Committee.

There will be those, doubtless, who will say that such publicity work is undignified and even unprofessional. Such a viewpoint betrays dense ignorance of actual conditions at the present day. It is of the greatest importance, both for the welfare of the public and the engineering profession, that the public should have a more intelligent understanding and appreciation of the work of the engineer. Every engineer of long experience can recall many cases where the greatest difficulty he has had to contend with has been to make those for whom he was working—public authorities, boards of directors, or private clients—understand and appreciate the importance of the particular task in engineering under consideration and the need for its study on broad lines.

By way of concrete illustration there may be instanced the work on the Panama Canal. No engineering work carried out for a generation has had the nation-wide publicity that has been given to this work by the newspapers. This has come about, of course, because of the conditions under which the work has been done, and entirely without effort of any sort on the part of the engineers in charge. No one can fail to realize that the creditable manner in which the work has been carried out and the extent to which this has been spread before the public by every newspaper in the country has raised the engineering profession enormously in the public esteem.

Every large business organization nowadays recognizes the great value and importance of publicity, and this not merely from the point of view of the sales department alone. High standing and reputation in the community are just as important a factor to a corporation or a firm as they are to an individual. Exactly the same rule applies to a profession. Any method by which it may have its work, its achievements, its standards, and its aims laid before the public which it seeks to serve, is a matter deserving serious attention.

Letters to the Editor

The Stony River Dam; Sliding as a Danger in Hollow Dams

Sirs—the writer would like to venture an opinion as to the cause of the failure of the Stony River Dam of the West Virginia Pulp & Paper Co., Jan. 15. This dam was briefly described and compared with three other proposed types in ENGINEERING NEWS, Sept. 5, 1912, p. 446, and the writer discussed this design with his students in reinforced concrete at that time. It was pointed out that in several articles in the technical press the question of resultant thrust had been carefully considered and it had been shown that this thrust could easily be made to pass through the center of the base, by using a 45° slab and a base equal to $^4/_3$ the height of the dam, and would stay within the middle third for all possible flood heights, in fact would only reach the quarter point for an infinite depth of flood. Now this is all very interesting and shows a factor of safety against overturning that is most satisfactory, but what method is used to prevent the dam from sliding on its base?

A simple calculation shows that in the case of the Stony River Dam a coefficient of friction of about 0.52 is required to prevent sliding. The article mentioned above describes the soil at the dam site as "a yellow clay mixed with fine sand or gravel which is underlain by a stiff blue clay, and some seams of a black material occurring in places." At the best, this material could not be counted on to give a higher coefficient than 0.70 to 0.80 and when wet might give as low as 0.35. Moreover, the design shows weep-holes in the spread flooring, indicating that the designer expected water might, as it doubtless would, occur under the base. Under these conditions it is difficult to see what factor of safety there was against sliding except the shearing value of the concrete of the cutoff wall (which in this design is unreinforced) and the small 4-ft. wash wall at the lower edge of the floor that should most certainly not be counted on as offering any resistance.

Also, as the height of water back of the dam is increased, the pressure causing sliding and the weight of water on the dam increase by the same amount, but, as the coefficient of friction is less than unity the result of an increase in depth of water is the requirement of a constantly increasing coefficient of friction to hold the dam to its foundation. This feature is not so satisfactory and is not mentioned in the articles analyzing the stability of hollow dams, above referred to.

The writer criticized the design for the Stony River Dam for this lack of safety against sliding and for the idea, evidently prevalent in the minds of some designers, that these structures can be set down on the surface of the ground almost anywhere and practically no foundation is required. The first of these is a well recognized point of weakness in reinforced-concrete structures of the retaining-wall type. As regards the foundations the type of construction used for the Stony River Dam is justified only when the river bottom is (for example) a good hardpan, soft rock, or equivalent.

The cause of failure of this dam may prove to have been primarily the sliding of the dam on its base. At any rate this feature of these structures demands proper recognition in their design and construction.

J. K. FINCH.

Columbia University, New York City,
Jan. 17, 1914.

An Explanation of the Orpheum Theater Collapse

Sir—Referring to the failure of the Orpheum Theater, described in the issue of Jan. 1, I would suggest the following as the probable cause of failure, which would seem to fit all of the conditions as given in ENGINEERING NEWS:

The initial failure was the breaking in two by tension of the lower chord of the balcony truss. This could easily have been caused by excessive tension on one edge of the bottom splice-plate due to the lateral deflection of the truss which would necessarily take place after the cantilevers had received their load of concrete. As these cantilevers received a materially greater load than had been calculated for them, their deflection must have been considerable, exerting a large torsional moment in the main balcony truss. This is shown by Fig. 12 of the article. As the top chord was presumably rigidly held by the balcony floor, this torsion would be resisted mainly by the bottom chord in lateral bending, causing an uneven distribution of stress.

The occurrence of the break at the splice was probably due to the bottom splice-plate being of defective material, as indicated by the tests. It is reasonable to assume that a crack developed on the edge under the highest stress, and gradually worked its way across the splice through the rivet holes, until the entire section became too weak for the strain and a sudden failure occurred.

This failure of the bottom chord of the balcony truss, however, *did not cause the balcony to fall.* Assuming that the upper connections of the balcony held, and that the columns had considerable resistance to moving at the top, it is entirely possible that the balcony would be self-sustaining after the failure of the truss had allowed it to sag in or near the middle.

Had the balcony frame not been anchored to the roof columns 1 and 2, it is probable that complete failure of the balcony would not have occurred, or it would have been considerably retarded. The sagging of the balcony following the failure of the balcony truss pulled the roof columns 1 and 2 out of line at the point of attachment, the proscenium struts on the other hand restraining the columns, the result being that the columns were doubled up under their load. This would account for the bends occurring at the points at which the columns were stayed, which seems difficult to explain in any other way.

The final failure occurred when the roof fell upon the balcony. As this load must have struck fairly well along the entire width of the balcony, this did not affect the balcony truss materially, but exerted its force upon the balcony columns (Cols. 3 and 4), crippling them and allowing the entire balcony to drop. The reason these columns buckled in the direction they did is that they could not buckle in any other direction, being restrained by the attachment of the truss from moving to the north or south, and the force of the blow, striking the balcony from the front, preventing them moving toward the front.

The above progressive method of failure would account for the following otherwise unexplainable facts:

1. The main balcony truss remained reasonably straight. This could not have been the case had the balcony failed completely at first.

2. The balcony columns showed complete and simultaneous failure, out of proportion to the damage sustained by the balcony truss. If the failure had been primarily due to these columns, one would undoubtedly have failed and the other pulled over; on the other hand, had they followed the failure of the truss, they would either have fallen simply, or bent in the direction of the truss.

3. The roof columns (Cols. 1 and 2) failed simultaneously and in essentially the same manner. Had the initial failure been due to the lightness of these columns, one would have failed first, and the roof truss in falling would have pulled the other over or torn away.

R. E. KREMERS,
Chief Inspector of Construction, Bureau of Buildings.
Portland, Ore., Jan. 8, 1914.

Esthetics of the Hell Gate Viaduct

Sir—In your issue of Jan. 8, I noted two articles which concern engineering art, and one of which also bears on the economical preservation of property, not to mention the preservation of the nervous systems of humanity at large. These two articles are "The Hell Gate Steel-Arch Bridge," and a letter from William Hoeker pointing out the great opportunity the American engineer has to erect artistic engineering structures.

While admiring the design of "the longest steel-arch bridge in the world," I should be glad to know if there is a real and vital reason for adopting a steel viaduct approach such as is indicated on your drawings.

I have seen the piers which have been erected for the approach, and know the deteriorating and nerve-racking noise which is likely to accrue from trains passing over such a structure. I also realize what a great opportunity has been lost in the shape of the possible erection of a structure that would have been a credit to the landscape, which is here really quite striking, certainly one of the beautiful parts of New York City. I am, therefore, surprised that the art censorship of the Art Commission of New York, or whatever body takes care of such matters, has permitted the building of approaches of steel girders. I cannot see what was to prevent the building of these approaches just as economically with concrete arches—in fact more economically because of the opportunity of using the arches for house accommodation, warehouses and shops, or at any rate providing a space to be rented for some purpose or other. The arches could be built with fine architectural effect, and in such a way that screen walls could be carried up on both sides to, say, 15 ft. above base of rail, with the result that noise of traffic would be almost entirely eliminated. Such a structure would be almost as silent and picturesque as one of the beautiful old aqueducts still to be seen in the older countries. It is nothing new to have shops and stores under the arch masonry approaches of railroads. Instead of such a structure's depreciating adjacent property, it would have the reverse effect.

I think it is very much to be regretted that the approaches are thus designed. As a matter of fact, I believe it will also detract from the beauty of the central span.

Engineering includes more than the consideration of merely the direct function of a structure. The secondary and auxiliary functions and relations should also be regarded. Possibly this in itself would meet the demands of art; if not, esthetics should be considered.

AN ADMIRER OF THE CENTRAL SPAN.
New York City, Jan. 16, 1914.

Construction Features of the Stony River Hollow Concrete Dam

By G. H. Bayles†

The failure of the Stony River Dam, a hollow concrete structure recently completed in West Virginia, occurred on Jan. 15. Exaggerated accounts of property damage by the failure and resulting flood published in the newspapers have called general attention to the structure. The article below, written by the constructing engineer of the dam describes the difficulties met with in the foundation and is of great interest since the dam's failure resulted from a leak beneath it.

SYNOPSIS—In Engineering News, *Sept. 5, 1912, p. 446, an article by Edward Wegman described four alternate designs for a hollow concrete dam on Stony River, Grant County, West Virginia, which was to impound water to be used by the West Virginia Pulp & Paper Co. in the manufacture of paper. As noted there, the design selected was that made by the Ambursen Hydraulic Construction Co., of Boston, Mass. The article below describes in detail the difficulties met with in the construction of the dam, and also the construction plant and methods used, many of which are applicable to other work than dam construction.*

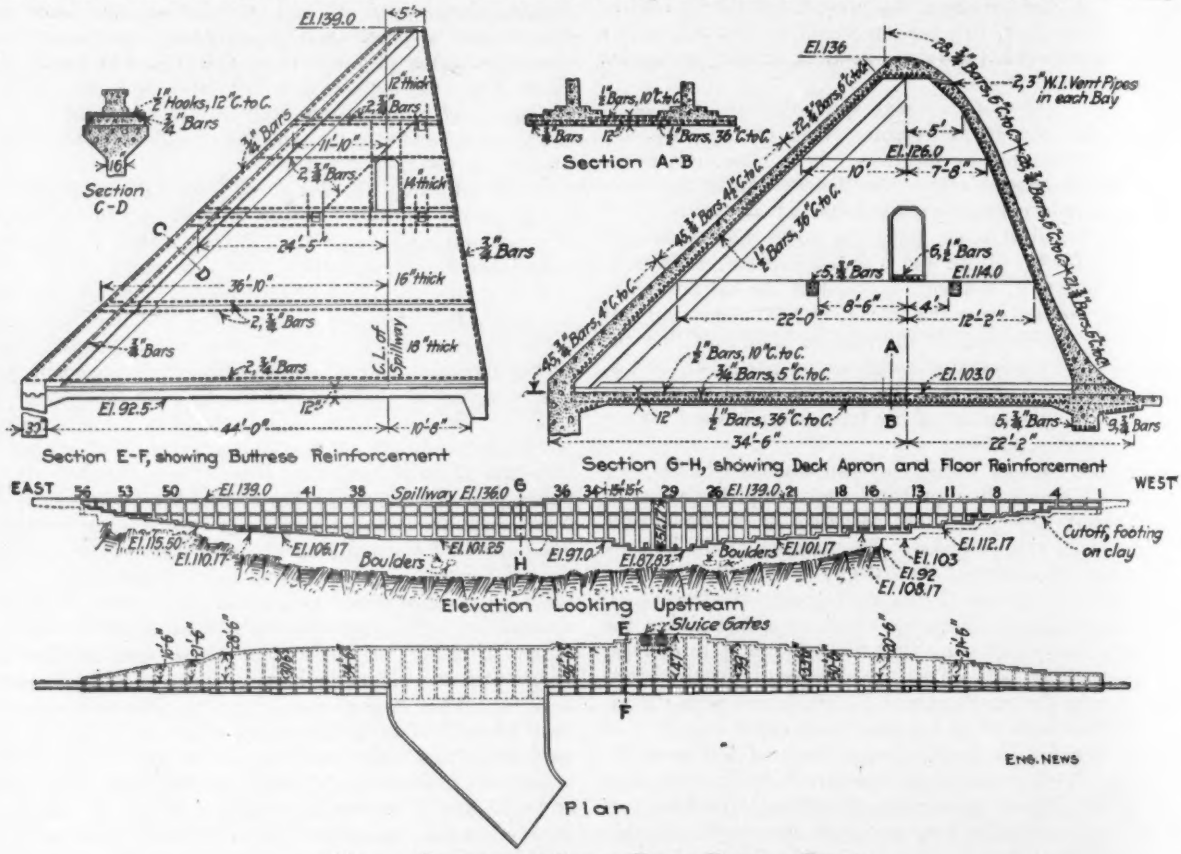


Fig. 1. Details of Stony River Dam as Built

Design

Some slight changes in design were made to suit conditions as they presented themselves; they may be seen by comparing the plan of the dam as actually built (Fig. 1) and the plan as given in Engineering News, Sept. 5, 1912. The changes are principally: the extension of the hollow section to where the flow line at the beginning of the overflow (Elev. 136) intersected the center line; the building of a solid concrete wall 2 ft. 6 in. thick from those points to a point at each end about 6 ft. beyond where the surface of the ground reaches the elevation of the bulkhead crest (Elev. 139), the top of these walls being at the same elevation as the bulkhead crest and the bottom extending at least 6 ft. below the surface of the ground; the deepening of the toe wall across the river from 3 ft. to 6 ft.; a change in the plan of the spillway hearth and the construction of a 4x4-ft. wasteway.

Contractors

The contract was let to Fred G. Webber, of New York City, for the lump sum of $143,000, the owner arranging with the Ambursen Hydraulic Construction Co., owners of the patent rights of the Ambursen-type dam, for the use of their design and for the plans for the dam. The work was to begin about June 1, 1912, and to be completed by Jan. 1, 1913. The progress of the con-

†Consulting Engineer, Third National Bank Bldg., Atlanta, Ga.

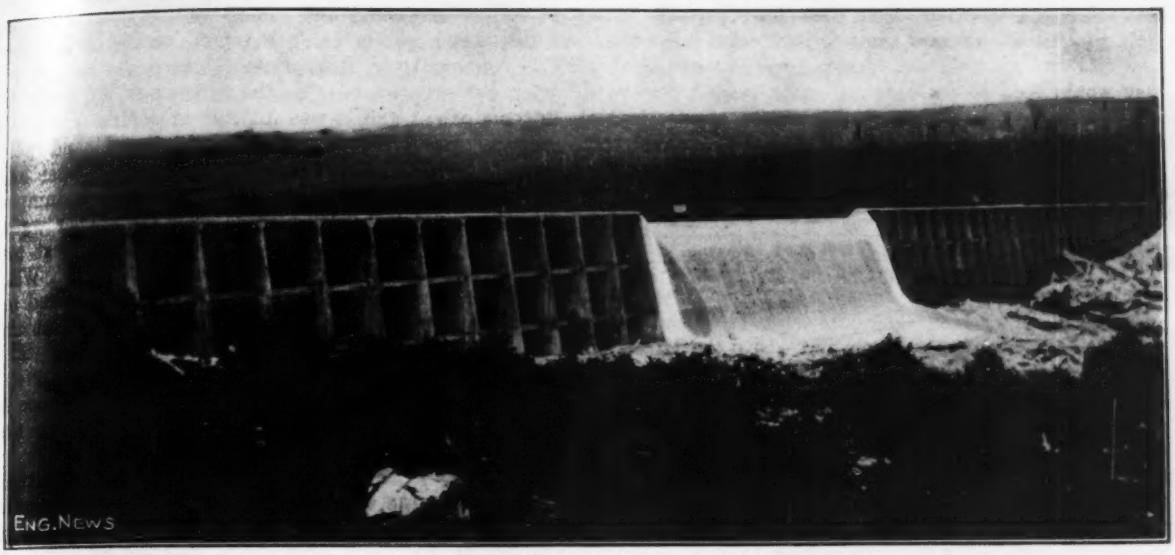


FIG. 2. DOWNSTREAM VIEW OF COMPLETED STONY RIVER DAM

tractor not being satisfactory to the owner's engineers, the owner took the work out of his hands Mar. 13, 1913, and employed the Ambursen Hydraulic Construction Co. to finish the dam.

CONSTRUCTION RAILWAY

The site selected for the dam is in a comparatively shallow valley at an elevation of 3300 ft. above sea level. The sides of the valley rise gradually to the tops of the surrounding mountains, which reach elevations varying from 3800 to 4200 ft. The nearest railroad station is Dobbin, on the Western Maryland R.R., distant 19 miles from the dam site. There is a standard-gage log road owned and operated by the Parsons Pulp & Lumber Co. extending from their mills at Dobbin to their camps in the spruce woods on the mountain and passing within two miles of the dam site, with an unused branch 1¼ miles long extending from the top of the mountain down to Stony River, some three miles above the dam. The main-line log road is laid with 60-lb. rails for half the distance and 45-lb. for the remainder. The branch is laid with 35-lb. rail. The paper company extended the branch over an old narrow-gage log-road grade to the dam site, using 60-lb. rail and standard cross-ties, and renewed about 1500 cross-ties on the branch.

On this extension five bridges and two trestles were built. They were all small and their construction was simple. Cribs of rough logs that had been left by the timber men were built each side of the stream and stringers of the best-grade spruce logs laid across from crib to crib. In one case an additional crib in the middle of the stream was necessary. The cribs were filled with one-man stones. Later an extension was built by the contractor to his quarry and another extension about 2200 ft. long was built by the second contractor to the site of the new plant, on both of which 25-lb. rail was used because it could be obtained at the time from the lumber company. Aside from some trouble keeping the track in surface on its narrow bed, the 60-lb. rail proved satisfactory. The 25-lb. and 35-lb. rail proved too light for the heavy loads that had to be handled and was a constant annoyance on account of the many derailments and broken rails. All men and materials were handled over these lines.

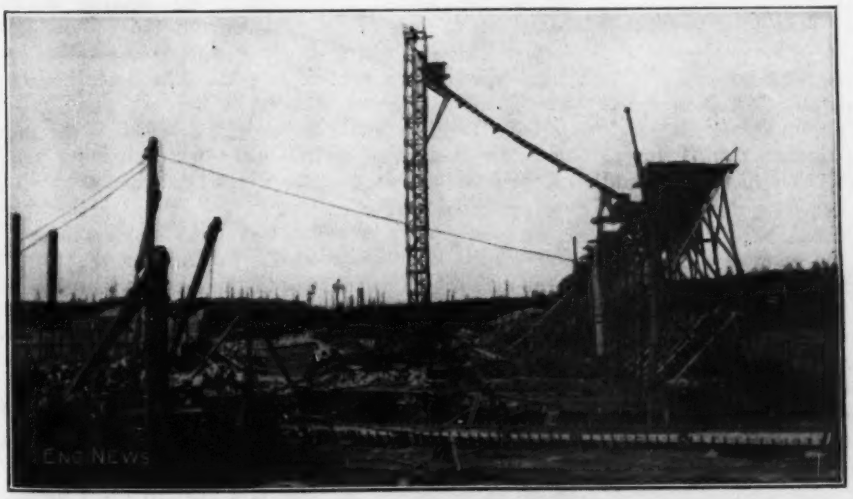


FIG. 3. CONCRETE TOWER AND TRESTLE, RIVER FLUME IN FOREGROUND

ORIGINAL CONSTRUCTION WORK

PLANT—The original construction plant included a stone-crushing and concrete-mixing plant near the middle and behind the dam, with a concreting tower from which concrete was chuted into a hopper above the trestle and carried thence by cars to its place in the dam.

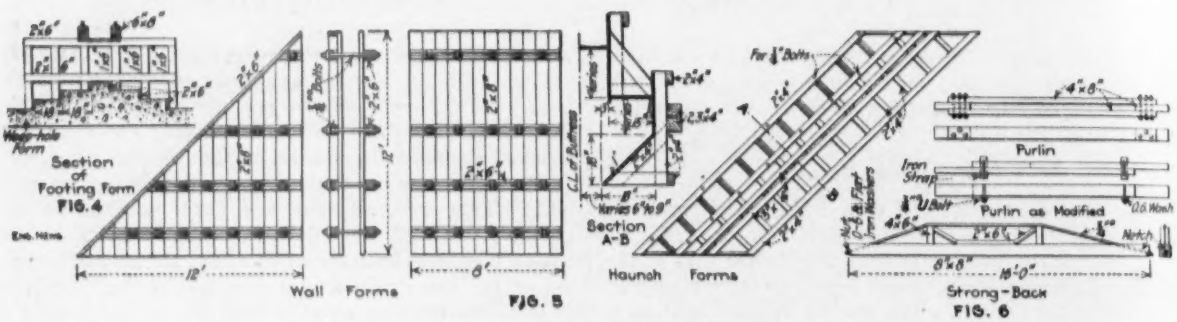
The crushers were located about 100 ft. from the railroad

track. The bins were about 16x40 ft. in plan with bottoms sloped about 30° from the sides toward the middle. Specially built cars ran on the tracks under these bins and two spouts from each bin were so placed that they would feed to the cars on either track. The cars were built on the job and had separate compartments for stone and sand, each just sufficient size to hold the proper quantity for a batch of concrete. The mixer platform was at the same elevation as the floor of the cement house with plank runways leading to the cement house.

The batch cars were hauled to the mixer by the hoisting engine at the tower and run back to the bins by gravity. A wooden tank was built near the mixer and was connected to the batch tank above the mixer by a 1½-in. pipe. The flow to the batch tank was controlled automatically by a float valve. The large tank was filled by the boiler-feed pump and the piping was so arranged that steam could be turned into the tank to heat the water during cold weather. Three 4-in. steam pipes were laid the length of both the sand and stone bins, immediately above the outlets, and were sufficient to heat the materials during the coldest weather.

as the crushed stone to the screen. The screen was set to deliver only sand and run-of-crusher stone. No attempt was made to grade the product and with these long, comparatively flat-bottomed bins it did not always work out satisfactorily, as the product would separate to some extent and it was difficult to get the materials properly proportioned. The dry stone and sand were dumped from the batch cars into the mixer hopper and the cement added. The whole dry batch was then dumped into the mixer and when all was clear the hopper water was added. The mixer was then revolved at least ten times before the batch was dumped into the bucket. With the mixer making 18 r.p.m. a batch could be mixed on an average every 75 sec,; the batches were mixed at the rate of one in 70 sec. for half-an-hour at a time. The batch was hoisted in the tower and dumped via the chute into the storage bins above the trestle. Thence it was taken in the steel cars and dumped through the spouts into the forms.

Forms—The forms for the footings, besides the skeleton form for the steps shown in Fig. 4, consisted of a bulkhead at each end and one on the downhill side where the step-up wall was poured with the footing. On the



Figs. 4-6. Forms for Stony River Concrete Dam

Fig. 4. Section of footing form.—Fig. 5. Buttress form.—Fig. 6. Strong-backs and purlins.

The chute (Fig. 3) was suspended from the tower to the trestle to carry the concrete across the work, this chute discharging into small storage bins which were set with their drawoff gates about five feet above the floor on top of the trestle, the bents of which were spaced the same as the buttresses of the dam and stood between them. At intervals long light booms were attached to the trestle legs and used for handling forms. A number of chutes and spouts were made as the work progressed and were moved from place to place as required.

The river here is of small low-water flow so that construction could be carried on straight across the gorge, caring for the river in a wooden flume (Fig. 3) during the construction of the cutoff wall and footings in and near the river. Not more than two days' time was lost on account of the overflow of the flume.

Concrete Making—Rock for the concrete was at first gathered along the railroad and loaded by hand onto the standard flat cars. This was soon seen to be very expensive and a siding was built to an unusually large deposit of boulders and the rock was loaded into skips on small push cars and lifted by a derrick onto the railroad cars. The product of one crusher went directly by elevator conveyor from the crusher to the screen; that from the other crusher went first to the sand rolls, passed through them and thence by the same elevator conveyor

uphill side the footing extended against the bank and formed a foundation for the next step-up wall. These forms were knocked down and rebuilt for each separate footing. The buttress forms consisted of two separate parts, the walls and the haunches. They are shown in detail in Fig. 5 and in the view in Fig. 7. Blocks were set in the haunch forms which left notches in the haunches to receive the purlins for the bottom-deck forms. After a buttress lift had been concreted, the form was lifted a section at a time to the lift above, leaving off one or two sections of the wall form as required. The blocks and tackle were attached to the trestle or the booms and the fall was worked either by hand or, when convenient, over the winch heads of the hoisting engine at the mixer.

The deck forms were built in place and taken down and rebuilt after being used. Purlins for the bottom form were set in the notches in the buttress haunches as above and ⅞-in. sheeting nailed to them, often making the bottom form complete from bottom to top of a section at one time (Fig. 7). The sheeting for the top deck form was made up into sections about 3x14 ft., with ⅞-in. sheeting on ⅞x4-in. strips; these were placed across from one buttress to the next, 3x4-in. studding were laid 20 in. apart on top of the sheeting and strongbacks placed on top of these and held in place by two

4x4-in. strips at each end fastened to the buttress by ¾-in. bolts set in the concrete. Five 8x8-in. strong-backs were first tried for a 12-ft. lift. This was increased to 15 and finally abandoned and a built-up strong-back, as shown in Fig. 6, substituted, using 10 to a 12-ft. lift. Five ¾-in. bolts were tried at first to hold the strong-backs. This number was gradually increased to 10 and the number of bolts in the buttress forms doubled. Standard cast-iron ogee washers were used over wooden washers, but the wood proved too soft and flat iron washers were later used between the cast-iron and the wood.

Footing Construction—Excavation for the footings of the buttresses, or floor of the dam, was carried down only far enough to reach good firm clay and to make the steps up from the river toward the ends of the dam at regular intervals corresponding to the spacing of the buttresses. Concrete construction began at the west end of the dam and progressed eastward, the plan of the contractor being to work a few sections at a time from bottom to top. When a section was completed the forms were lowered to the ground and carried by hand to the place where they were to be used next.

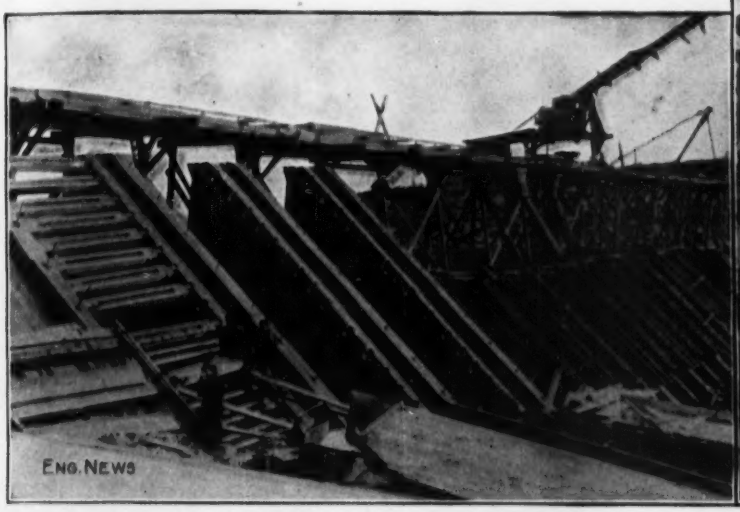


Fig. 7. View of Dam during Original Construction, Showing Concrete Chute, Buttresses, Buttress Forms, Purlins, Etc.

Where the head was to be less than 25 ft., the cutoff wall was carried down 6 ft. below the top of the floor and the clay from the excavation backfilled over the heel of the dam, the concrete cutoff wall being 2 ft. 6 in. thick. For heads of 25 ft. and over, the wall was carried down to solid rock, the "solid rock" in this case being a hard, fine-grained shale, firm and solid underground, but crumbly after exposure to the weather. The preliminary profile, made from clay auger-test borings, indicated that this shale would be encountered not over 25 ft. below the surface. Excavation for the deep cutoff was begun, using 2x10-in. vertical sheeting, driven by hand, with wooden mauls, with 4x6-in. wales about 3 ft. apart vertically and 4x6-in. shores, 6 ft. apart horizontally. The excavated material was hoisted in specially built buckets by steam derricks, which were moved from place to place as the work progressed.

The work proceeded without incident until a point some 400 ft. from the west end of the dam and near the west bank of the river was reached. Here, instead of encountering the solid rock as indicated on the profile, a bed of boulders, some so huge that the excavation was carried under them, mixed with sand and gravel was encountered and the solid rock was found at a much greater depth, at one point 44 ft. below the floor of the dam. The position and nature of this very porous stratum made it necessary to carry the cutoff clear through it to solid rock. Horizontal sheeting was substituted for vertical, the bracing then consisting of 4x6-in. verticals 6

Fig. 9. Lowering Concrete into Special Final Construction
(Note strong-backs and purlins in foreground.)

ft. apart and the same number and sizes of shoring as were used with the vertical sheeting. It was found to be much easier and cheaper to place the sheeting horizontally than vertically. There was always a space of from three to six feet cut through the semisolid rock at the bottom of the ditch that required no sheeting, and with the exception of the first six feet of the deep cutoff, all sheeting remained in the ground. All the shoring was removed.

There was considerable running water in the loose rotten rock that formed the top of the solid shale and the stratum of sand and boulders was saturated, but after the first section of the deep ditch was excavated it did not cause much trouble, as a space was always kept open for pumps and the water level kept below the excavation of the next section. In concreting a section, concrete was first poured at the deepest part of the ditch and pumps were placed in the other end of the section to remove the surplus water. Concreting was started on the

bare rock and kept coming fast enough so that concrete was always deposited on concrete and not in the water. Neat cement was spread over the clean rock surface and added to the toe of the concrete fill as it pushed its way along the ditch under a little water. No puddling was done under water.

Final Construction Work

When the Ambursen Hydraulic Construction Co. took charge of the work, a cableway was substituted for the tower and trestle for handling concrete and forms, and in order that storing water could be begun as soon as possible the whole plant was moved to the east end of the dam and remodeled to suit the workings of the cableway (Fig. 8). This required the addition of a concrete bucket to take the batch from the mixer via the cableway to the work and a specially designed car to receive the batch from the bucket and carry it to and distribute it in the forms. In order to keep the work going without interruption while the new plant was being set up, the old mixer was kept running and a ¾-cu.yd. batch mixer placed in the new plant. The bucket was bottom dump; the car was designed by the Ambursen Co. and was so built that the concrete could be received without slopping over and with a chop gate at one end so that the batch could be poured as slowly as desired (Fig. 9).

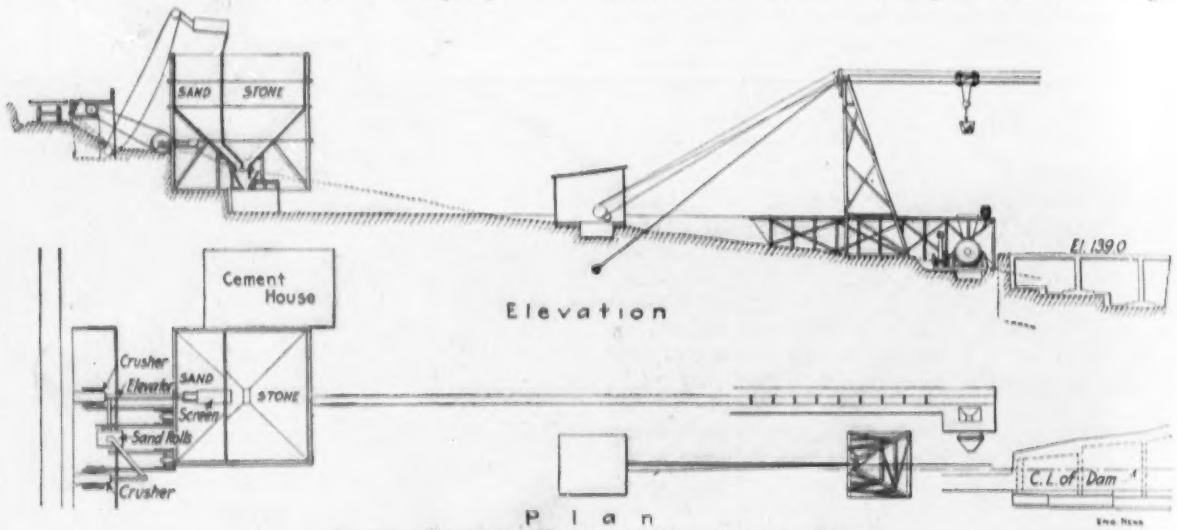


Fig. 8. Concrete Plant at West End of Dam

(This shows plant as equipped during last part of contract; the original plant was located in the middle of the valley and had a concrete-chute tower and trestle instead of the cableway.)

The car could be pushed slowly along the top of a buttress form or footing form and the batch distributed so evenly that a minimum of puddling was required. As concrete could be dumped only in the middle of the deck form, sheet-iron spouts about 8 ft. long were attached to the track and the lower end, extending down into the form, swung from side to side, distributing the concrete where puddling was most difficult. As it required from 2 min. to 3½ min. to transport a batch of concrete from the mixer to the car and return the empty bucket to the mixer, the capacity of this plant was limited and would not exceed an average of 120 cu.yd. a day.

Forms—The derricks were retained for the excavation of the cutoff trench and part of the footings, but as much as possible of the rest of the work was done with the help of the cableway. This necessitated some slight changes in the forms so that they would stand handling as units. The deck forms were made in one piece for the top and one for the bottom, using ten purlins for the bottom (spans 12 ft. and less) and ten strong-backs for the top (spans 15 ft.). To move these forms required one trip for the top, one for the bottom, one for the purlins and one for the strong-backs. Notches in the haunches were no longer made for the purlins, but a continuous shoulder was cast in the concrete and the purlins kept in place by wooden spacing blocks. The purlins were changed to a two-piece purlin, making their removal simpler, as well as making them stronger (Fig. 6).

At first the whole flat side wall of a buttress form was moved in one piece and each side of the haunch form in two more pieces, making six trips for a lift of buttress form. This was changed later so that a whole side form, including the haunch form, was moved in one piece, making only two moves for a lift. Tracks for the concrete car were made in lengths equal to the length of the top of the buttress form or a little longer than from the center line to the deck form and each section moved complete on the cableway. During the work a new buttress form was designed which included the track for the concrete car and was moved in two pieces. Scaffolding for the men placing and removing the bolts will be built onto the form and the bracing simplified. This will save the trip for moving the track and make the work of setting up much easier.

Cutoff Wall—When the Ambursen Co. took charge, the principle of keeping an open portion of the cutoff trench for a pump well was abandoned and the concrete filled up each time against the earth at the end of the excavation. For this reason the excavation was mostly wet and some difficulty was experienced by sand and small boulders working down from behind the sheeting and sometimes considerable quantities of concrete were required to fill the spaces excavated in that way. As the cutoff approached the point toward the east end where it was expected to rise to the 6-ft. wall, the sheeting was all removed. The porous stratum persisted so that it was found necessary to carry the cutoff to solid rock practically to the end of the dam. At times there was

trouble in removing the sheeting, owing to the tendency of the planks that had hollow spaces behind them to fall when the lower planks were removed.

At one time all the sheeting on the back of the ditch settled suddenly about a foot, carrying the shoring to an angle of about 20° to the horizontal and endangering the men working in the ditch, at that time about 35 ft. deep. New horizontal shoring was set from the top downwards and the concreting continued without further mishap. Generally the sheeting was removed without much trouble and was well worth the cost for use a second time. It required four men to loosen the shoring and sheeting and two to hoist it to the surface, only two more than were necessary for removing the shoring alone.

The last hundred feet of the ditch was through loose, shelving sandstone, becoming fairly monolithic at depths ranging from 8 ft. to 20 ft. Even at those depths crevices were still found in the rock. To guard against leaks through these, pipes were inserted in the crevices, and after the cutoff wall had been poured, neat cement

FIG. 10. CONCRETING SPILLWAY AND HEARTH, STONY RIVER DAM

grout was poured into these pipes as long as they would take any. A two-man hand force pump was used and 242 bbl. of cement was pumped into the pipes before the crevices seemed full. Several of the crevices seemed to be connected, as when one filled up the others would take no more grout. This was gratifying, as it seemed to show that all the crevices had been reached.

From end to end of the dam all the loose surface material was removed from near the back of the cutoff wall and good, clean clay puddled in to fill up over the heel of the dam to normal ground surface or above.

SPILLWAY

The spillway, as shown in the plans, was placed to one side of the river and the hearth was designed rectangular in plan, ending on the flat ground some distance from and 15 ft. above the river bed. This was changed in the field to extend down the river bank to the elevation of the river bed at the edge of the stream. The concrete floor of the hearth was 9 in. thick, laid in 10x10-ft. squares on 4 in. deep of broken stone (Fig. 10). The side walls were 6 ft. high near the dam tapering to 3 ft. at the river. A curb drain 3 ft. wide was built along the front of the dam to carry off possible overflow from waves.

CONCRETE

The concrete in the cutoff, footings, buttresses and spillway hearth is approximately a 1 : 2½ : 5 mixture. For the deck and apron the proportions are 1 : 2 : 4. This concrete was made so wet that the men working in it would sink to their knees, or nearly so. Care was taken always to have a little excess of mortar so that all the voids would be completely filled. The dry aggregates were first put into the mixer and as soon as the charging hopper was empty the water was added. In the first described plant there had to be a minimum of ten revolutions of the mixer after adding water before the batch was dumped. In the second plant the speed was limited by the cableway and the batch was always well mixed before the return of the bucket.

LABOR

It was feared there would be trouble keeping men in so isolated a locality, but once the organization was fully effected no difficulty was experienced more than would probably have been the case in a city. The traveling expenses of some of the higher class skilled men were paid by the contractor; the laborers' traveling expenses were paid by the contractor and later deducted from their pay. The accommodations provided for the men were as follows: the skilled men and the Americans generally were housed in buildings having separate rooms for each four men and a general lobby about 20x30 ft. in each building. The foreign laborers had just as commodious quarters but were in large dormitories, 20 or more in a room. Their houses were also provided with lobbies and had kitchens and dining rooms. Springs, mattresses and comfortables were furnished without extra charge to every man. The men occupying the more private quarters were charged $2 and the others $1 a month. The higher priced rooms were cleaned and the beds made up daily by flunkies hired by the contractor; the foreign laborers hired their own flunkies, but were required to keep their places clean. A doctor on a salary attended all men free of charge and looked after the sanitation of the camp.

The Americans and skilled men were provided with a first-class boarding house and the charge was made as nearly as possible the cost of the supplies and services rendered. It was found necessary on this basis to charge $5 a week for board. The foreign laborers were boarded under two systems: The Austrians, some of whom had their wives with them, preferred to run their own commissary. These were furnished provisions from the contractor's store at cost and hired their own cooks and helpers and the cost was proportioned among them according to the number of meals taken by each man. The account was turned into the office and the deductions made from the pay. The Italians preferred to board by the day and an Italian was engaged to run a boarding house for them, the contractor making frequent inspections to see that the men were properly fed. These men were charged 50c. a day and there were no complaints. The others paid from $2.50 to $3 a week.

COST DATA

The dam site is 19 miles distant from the nearest railway station, and all men and material had to be brought in over logging railroads, which materially affected the cost.

Various rates of wages were paid at the beginning of the work, but these soon settled to the following:

Mechanics, $0.30 to	$0.50	per hour
Carpenters, $0.30 to	0.35	per hour
Helpers	0.25	per hour
Laborers in cutoff trench	0.25	per hour
Other laborers	0.22	per hour

All field costs included the costs of the parts of the work with the last described plant and cableway were as follows:

Cutoff excavation	1,273	cu.yd. @	$2.93
Earth excavation	3,432	cu.yd. @	0.48
Rock excavation	44	cu.yd. @	3.43
Crushed stone and sand for 1 cu.yd. of concrete	1	cu.yd. @	1.23
Mixing and placing concrete	7,594	cu.yd. @	0.72
Forms (not including materials)	7,594	cu.yd. @	1.67
Placing steel	366,277	lb. @	0.005

The quantities from which the above figures were derived were made up from the number of batches placed. It was found that it required a little more than the figured yardage to fill the forms, say 5%, and where the concrete came in contact with the earth—the footings and cutoff—as much as 25% more than the neat quantities was required, and the average for footings was a little under 20%.

The whole back of the dam or top of the deck was washed with neat cement grout brushed on. This work was included in the contract and the writer has no figures of the actual cost. The work was done by laborers. The utility of such a wash is problematical, for if the concrete is well made, there will be no leaks and even where there is some seepage the silt in the water will no doubt close up the pores in a short time. With a head of about 25 ft. behind the dam when the work was finished there was no water coming through except moisture in a few places along the joints between the deck slab and the buttress, and this was in no case enough to run more than a few feet down the wall of the buttress.

Some Observations on the Construction Work

The following notes on the operations of the two plants described above may be worth while.

It was much better to have the crushers located so they could be fed from the railroad cars, thus saving rehandling the stone. It was worth while to build bins for both sand and stone, that would empty themselves by gravity of every piece of stone and grain of sand and have ample room for measuring bins beneath them. The arrangement of steam and water pipe for filling and heating the water for concreting was very convenient. Concrete can be handled more rapidly by tower and trestle than by cableway; if the Ambursen car had been used the placing would have been as satisfactory. The wooden spouts as used here were a failure.

While the lumber used for forms was only "sized," every indication was that tongue-and-groove lumber would have saved much labor and would have made a neater job. It pays to have forms so built and arrangements for handling them so made that they can be taken down and reset with as little loss of time as possible and as nearly as possible as units. This was done very simply and well with a cableway, but could probably have been done with a locomotive crane on the trestle.

It is worth while to keep a well below the excavation in such deep ditches as the one made here, allowing the ground water to drain away from the excavation. Horizontal sheeting was placed and removed with less labor and time than vertical sheeting (the excavation was through good, firm clay and a stratum of boulders and sand).

Very thorough mixing makes puddling easier as well as making apparently better concrete. A little excess of mortar also helps both in puddling and handling in buckets and spouts, and leaves less risk of porous concrete.

Frequent and regular pay days improve the morale of the men and consequently their efficiency.

Personnel

Thos. Luke, New York, General Manager of the West Virginia Pulp & Paper Co., and R. P. Bloss, Mechanicville, N. Y., Engineer for the company, had general charge of the work and Edward Wegmann, New York, was consulting engineer. In the field the writer was engineer-in-charge and F. W. Kellogg, who was responsible for the details of the design, laid out the work. Boyd C. Myers, Washington, D. C., was superintendent for Mr. Webber and Charles Hotaling was superintendent for the Ambursen Hydraulic Construction Co.

Strain and Expansion Measurements of Street Pavements

Tests on pavements at Kansas City, Md., are being made by J. E. Howard, of the U. S. Bureau of Standards, in coöperation with the City Engineer's Department. Clark R. Mandigo, Assistant City Engineer, is directly in charge of the work. Both the micrometer strain gage and a very sensitive spirit level have been employed in the work. The spirit level observations are used to measure the vertical motions of different parts of the pavement under load and under the influence of changing temperature during the day. Various types of pavement, for instance, showed a progressive rise of the crown and the development of transverse ridges as the day advanced. The recovery of the pavement from such motions and also from depressions under load has been similarly studied.

It is expected that this work continued for some time will give valuable insight into the physical behavior of various pavements and aid in judging the quality and value of pavements. One of the indications already obtained in a preliminary way is that pavements of the same kind but laid at different times, by different contractors and in different parts of the city, show close agreement in their behavior in these tests. The elastic behavior of cement-grouted brick-block pavement laid in the past two years corresponds closely for pavements laid in different streets and by different contractors. A similar statement might be made for concrete and for stone-block pavement, while, on the other hand, greater variation appears in asphalt and macadam pavements. These facts are quite in agreement with general ideas concerning the inherent uniformity of certain pavements as compared with others.

Generally speaking, the tests so far have shown the possibility of accurately measuring the deflection, recovery and permanent set of nearly every class of standard pavement used in Kansas City under a given load. Study of expansion movements with reference particularly to expansion joints is being carried on, but the results which will be obtained in this matter are not yet clear.

Break in the Stony River Dam

SYNOPSIS—Six months after its completion the 50-ft. high Amburgen Dam of the West Virginia Pulp & Paper Co. across Stony River, near Dobbin, W. Va., broke Jan. 15. The valley being uninhabited, little damage resulted. Five bays of the dam went out. The cutoff wall under the dam did not go to rock at this point. Clay soil with sand pockets. Leakage under dam showed at least a day before break.

After indications of pronounced leakage under the floor of the dam for at least 24 hr., five bays of the reinforced-concrete dam on the Stony River, West Virginia, described on p. 204 of this issue, went out at 9:20 a.m. on Thursday, Jan. 15. As the capacity of the reservoir formed by the dam was quite small (about 1200 million gal.; the drainage area of the reservoir is only 12 sq.mi.), and as a considerable quantity had filtered out slowly through the leak, the rush of water at the time of the final break was comparatively small. This water had to pass down through 20 miles of the Stony River Valley, which is totally uninhabited except for one trapper's hut about half way down, and reached the south branch of the Potomac River some 20 miles above Piedmont, where is situated the mill of the West Virginia Pulp & Paper Co., for which the reservoir on the Stony River was designed.

The total damage done by the flood waters was the destruction of one small highway bridge across the Stony River near its point of entering into the Potomac, and two very small washouts on the Western Maryland Ry., which runs alongside of the Potomac River. The water at Piedmont was about 5 ft. above normal, which is less than the usual spring flood.

Newspaper accounts greatly magnified the amount of property damage and risk to downstream residents, but practically the only damage was to the dam itself. Some excitement occurred in Luke and Piedmont, due to exaggerated reports, but this was soon dispelled.

The incidents preceding the failure of the dam are as follows: On Wednesday, Jan. 14, the superintendent of the pulp mills at Luke, Md. (immediately across the Potomac River from Piedmont, W. Va.), telephoned to an attendant who lived at a house on the dam site to open the gates and to let water down the Stony River so that the water level at the mills on the Potomac would be raised. The minimum temperature that morning was 10° below zero at Luke and was probably lower in the mountains where the dam is located. Ice to the thickness of 12 in. had made on the pond some time before. The attendant replied that the gates were frozen as a result of a leak through a construction joint in the deck of the dam, and he was unable to open them. Later in the afternoon the attendant called up the superintendent at Luke and said that he had forgotten to tell him that there was a bad leak showing through the weep-holes in the floor of the dam near Buttress 13. Before any further information could be secured from him, the telephone communication was interrupted. The superintendent of the same company's mills at Davis, W. Va., a point nearer the dam than is Luke, was notified of the trouble and immediately started across country through a blinding snowstorm to the dam site.

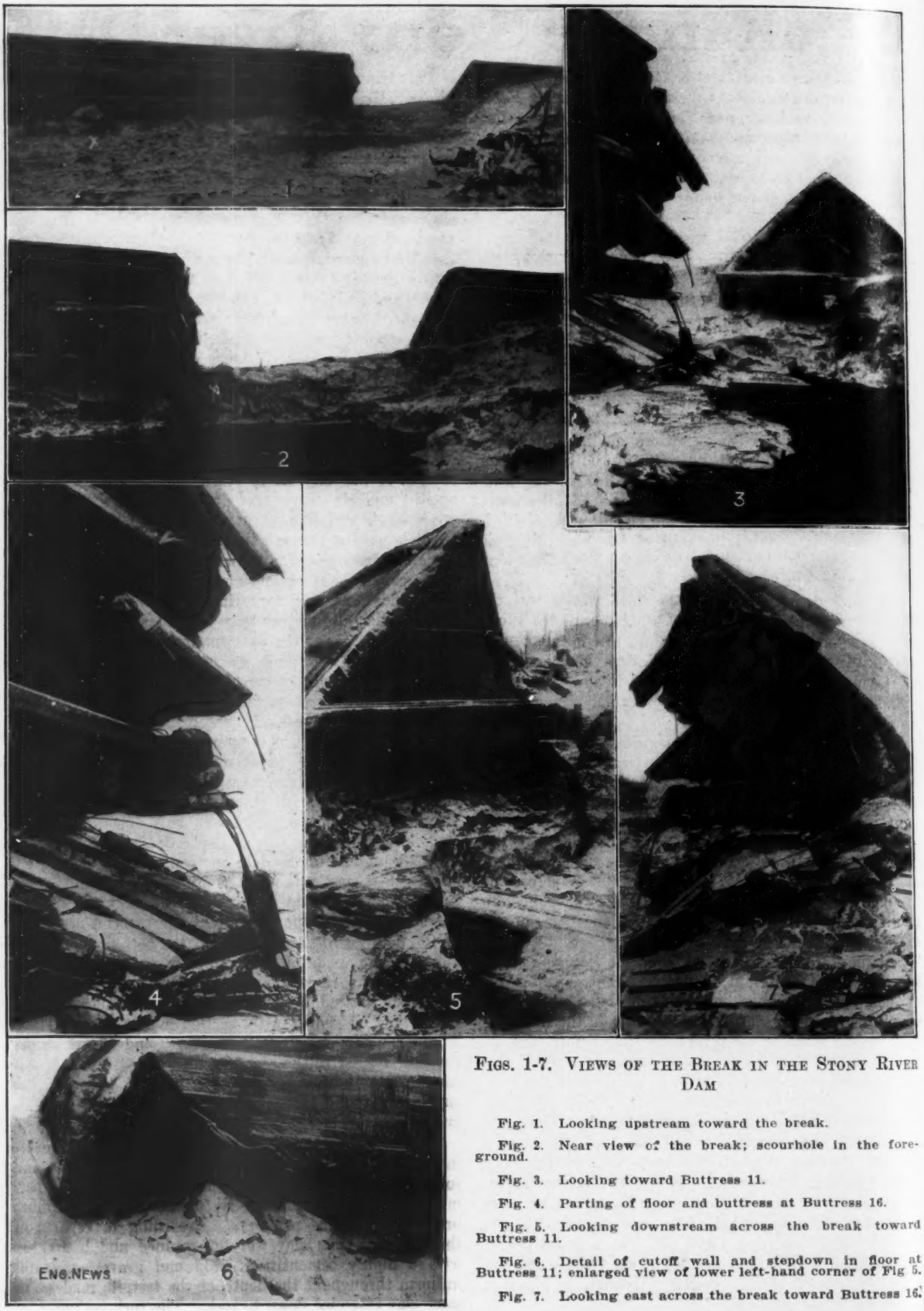
This trip across country took the superintendent some 15 hr. He reached the dam site about 9 a.m., Thursday morning, Jan. 15, and found a large stream of water flowing out under the dam near Buttress 13. Enough water had already escaped at that time to lower the pond above the dam 2 ft. from El. 136, the spillway crest, to El. 134. The escaping water blocked the way to the sluice-gates, so that it appeared impossible to draw off the pond. At 9:20 the floor of the dam, which was by that time spanning several bays over the hole scoured out by the escaping water, failed in flexure and let the buttresses and deck fall into the opening. The rushing water tore out the structure from a point just east of Buttress 11 to a point just west of Buttress 16. The floor was underwashed for some distance east of Buttress 16 and dropped into the hole. The damage to the dam does not extend west of Buttress 11, nor east of Buttress 18.

On Friday, Jan. 16, it was found that the gates had not been clogged, as reported by the attendant, but the ice had merely covered the staircase leading to the gates, so that it was difficult to reach them. The gates were opened and the water was drawn down to the regular creek level, and now only the ordinary flow of Stony River is passing through the gates.

Before describing the present condition of the dam at the break, a brief statement as to the investigation of the foundations, supplementing the notes by Mr. Bayles in the article on another page of this issue, is necessary.

In preparing for the construction of the dam, exploratory test pits were made at intervals all the way across the dam site along the crest line, which it will be noted from the drawing on p. 204 is some feet away from the line of the cutoff wall. In general, these test pits were 7x7-ft. excavations, which extended down a general average depth of 18 ft. If rock was not found at that elevation, coal-auger borings were made from the bottom of the pit a maximum distance of 14 ft. farther. In the entire number of test pits driven only one did not find some kind of rock by this method. Many of the pits toward the middle of the dam exposed shale at the bottom of the 18-ft. test pit, while many others did not reveal rock except as it was supposedly reached with the end of the auger. In the test pit at the extreme west end of the dam no rock was found at the bottom of a 14-ft. auger boring made at the bottom of an 18-ft. test pit; that is, rock surface was at that point more than 32 ft. below the ground level (which level is about the level of the floor, as shown in the section in Fig. 1 on p. 204). At the test pits driven at Buttresses 8 and 15, which are the pits nearest to the section which failed, no rock was found at the bottom of the 18-ft. test pit, but rock was supposedly found somewhere near the end of the 14-ft. auger boring.

The surface material was a yellow clay. The engineers in charge of the work called this material hardpan, and judged it to be of sufficient strength and stability to permit founding the floor directly on it, with a maximum pressure of 2 tons per sq.ft. According to reports of the engineers this clay was fine-grained and bound up with a highly cementitious sand and gravel, and was uniform throughout the depth of the testpits made. The same clay extended down to rock. The rock, as noted by



FIGS. 1-7. VIEWS OF THE BREAK IN THE STONY RIVER DAM

Fig. 1. Looking upstream toward the break.

Fig. 2. Near view of the break; scourhole in the foreground.

Fig. 3. Looking toward Buttress 11.

Fig. 4. Parting of floor and buttress at Buttress 16.

Fig. 5. Looking downstream across the break toward Buttress 11.

Fig. 6. Detail of cutoff wall and stepdown in floor at Buttress 11; enlarged view of lower left-hand corner of Fig 5.

Fig. 7. Looking east across the break toward Buttress 16.

FIG. 8. LOOKING UPSTREAM ACROSS SCOUR HOLE TOWARD EAST END OF BREAK
(Deck shown hanging over side of buttress 16.)

FIG. 9. BREAK IN DECK ABOVE BUTTRESS 16

Mr. Bayles, was a hard, fine-grained shale, firm and solid underground, but crumbly after exposure to the weather.

On the basis of these investigations it was decided to build the floors and buttresses of the dam on the clay as a footing and to run a cutoff wall on the heel of the dam to a clear depth of 5 ft. below the bottom of the floor at all points where the head was less than 25 ft., and to a depth of 10 ft. at points of higher head.

Work was started on this basis, but in excavating for the cutoff wall about 125 ft. west of the creek, i.e., about Buttress 28, a shallow pocket of black water-bearing sand, apparently of coal origin, was found some 10 ft. below ground surface. Apprehending water percolation through this stratum, the engineers on the work, after an investigation of the excavation, decided to run the cutoff wall to rock for a distance of at least 125 ft. on either side of any appearance of this black-sand pocket, the remainder of the cutoff wall to be sunk to the previously determined 5-ft. depth. On this basis the work was carried out. The cutoff, as shown in the profile in Fig. 1, p. 204, extended to rock from a point about midway between Buttresses 15 and 16 to midway between Buttresses 54 and 55, at some places toward the middle of the dam reaching as low as 44 ft. below ground level. At the end of the cutoff wall on the west, between Buttresses 15 and 16, the cutoff wall was stepped up to the stipulated 5-ft. depth, following the changes in elevation of the floor at that distance below the floor level. On account of the changes in elevation being made by slopes, there were places where the cutoff wall was less than 5 ft. below the bottom of the floor of the dam.

The dam was finished July 15, 1913, but storage of water was commenced about May 15.

APPEARANCE OF THE BREAK

Most of the views which accompany this article were taken on Saturday, Jan. 17, two days after the break. On account of a heavy snowstorm which was in progress while the pictures were taken they are somewhat indistinct, and on account of the snow covering, various broken parts are not so clearly outlined as they might be. The break extends generally from Buttress 11 to Buttress 16, with minor cracking showing beyond those points. The deck was laid as separate slabs with construction joints at the buttresses. It is cleanly removed from the middle of Buttress 11 to the middle of Buttress 16. But-

tresses 12, 13, 14 and 15 are out, and the floor is out from the stepdown just east of Buttress 11 to Buttress 16. Between Buttresses 16 and 18 the rushing water has underwashed the floor, whose downstream edge has dropped some 4 to 6 ft., and Buttress 17 is supported entirely from above, practically all of its floor support being removed. The break on the west side, at Buttress 11, is clean, some few rods sticking out of the lowest floor at the stepdown.

The cutoff wall at Buttress 11 (Fig. 1) measures 4 ft. 4 in. to the bottom of the floor on the inside, and 5 ft. 3 in. to the line of the clay on the outside. It is 2 ft. 6 in. in thickness. Practically all of the broken floor and some of the buttresses are lying in the gap left by the break, but the most of the deck and some of the floor and a part of the buttresses are downstream. A large pile of this material tied together with twisted rods into a mass about 20 ft. cube is lying some 300 ft. downstream just west of the river bed. The water rushing out through the gap followed pretty closely the line of the dam for some distance down the side hill, which accounts for the location of the débris at this point. Other pieces of débris of smaller size were found as far as 1000 ft. downstream.

On the east side of the break (Buttress 16), the wreckage is much greater than on the west. The floor between Buttresses 16 and 18 has dropped and the deck between Buttresses 15 and 16 has fallen to cover the whole west face of Buttress 16, so that it is difficult to determine the nature of conditions under that buttress. The cutoff wall between Buttresses 15 and 16, shown in the profile in Fig. 1, p. 204, as reaching to rock, is also partly concealed, but can be dimly made out, and appears to extend lower than the shallow part of the cutoff, which has disappeared. On account of the construction joints between floor and buttress and buttress and deck, these three parts are separated quite clearly in all the débris.

The crest line of the dam is quite straight, except for a slight bend at Buttress 17 (due no doubt to the crack in the floor below). The remainder of the dam is in good condition, except for the pronounced leakage which shows through the construction joints of the deck on buttresses at two places near the middle of the dam and about above the sluice gates. At these points water has evidently been coming through the expansion joints for some time, for the whole side of the buttress is in each case covered with a heavy armor of ice some 3 ft. in thickness. So far as a casual inspection shows, the construction joints along the rest of the dam have apparently not been working. It would seem as though the contraction became localized in a few of the spans of the deck, and thus formed pronounced openings at the two points noted.

Immediately upstream of the break, the ground surface has been torn out by the flowing water so that there is a sheer face some 10 ft. deep. The bottom of the scoured-out area is about level, under the dam, but at or near the downstream edge of the dam there is a further drop into a deep pool, where water now is. The level of water in this pool is about 14 ft. below the floor of the dam, and soundings showed bottom in the pool about 17 ft. farther down, so that the depth of scour just downstream of the dam is about 31 ft. below the floor of the dam. This scour-hole is in the side, rather than in the bottom, of the valley.

Although the ground in the hole torn out by the rushing water has been frozen, it was possible to discover in it several conditions not predicted by the borings. The upstream face of the scour-hole shows a thin stream of water-bearing black sand not far below original ground-level, apparently similar to the black sand which was found in the borings near the middle of the dam. Otherwise, the face shows clay, presumably the same as found in the borings.

Many clay fragments found around the scour location show adherent pieces of shale. If this indicates that the clay scoured out down to rock, taking with it fragments of the rock, it agrees with the fact that soundings in the water pool strike a hard surface with a few inches of soft covering.

The concrete in the dam seems to be very good, although the aggregate is somewhat smaller than is usual in such structures. It is of a peculiar brown color, not usually found in stone concrete. The rods, of a special deformed type, in practically every case are stripped from the concrete.

The dam is in a peculiarly isolated location. It is at the head of a rocky, mountainous stream (Stony River), which falls 1800 ft. from the dam site to its mouth at the Potomac River 20 miles farther down. The nearest railway station is Dobbin, W. Va., on the Western Maryland R.R., from which point a standard-gage logging railroad, belonging to the Parsons Pulp & Lumber Co., runs up into the mountain to an elevation some 4200 ft. above sea level to a number of logging camps. This logging railway reaches within two miles of the dam site at a point about 13 miles from its terminus at Dobbin. Continued snowstorms all during the month of January have tied up the logging road so that its operation during the week of the failure of the dam was extremely uncertain. Some of the few engineers who got to the site of the dam on Saturday, Jan. 16, were able to get in by the logging road to a point within two miles of the dam where they could walk through from one to three feet of snow in the woods to the dam site. But those who tried to reach the dam Sunday found the logging railway tied up by snow, so that a number of men had to walk the 15 miles to the dam through deep snow. The logging railway was put in operation again on Monday morning and was then used as the main line from Dobbin to the dam site. The courtesy of the Parsons Pulp & Lumber Co., in allowing the free use of their railway, when it was in operation, to all who cared to go to the dam was much appreciated by those engineers who reached Dobbin in pursuit of information. The West Virginia Pulp & Paper Co., the owner of the dam, also did everything in its power to make information accessible.

Substitution of Subways for Elevated Tracks in Boston has been reported against by the Boston Transit Commission. Petitions have been presented to previous legislatures urging that the elevated railways in Boston and Charlestown be removed and subways built in their place extending to Douglas St. in one direction and to Sullivan Square in the other. The petitions were referred a year ago to the Transit Commission for investigation. In its report just rendered the Transit Commission advises that the cost of such a change would be over $13,000,000. The Boston Elevated Co. is not financially able to make such a change, nor could it be legally compelled to do so since it has a property right in its present lines. If, therefore, such a change were made, it would have to be borne by the taxpayers of the city as a whole, and the Commission advises that there is no increase probable in the values of the abutting property by which the taxpayers would be compensated through an increase in the assessed valuations.

The Proposed Merrimac Valley Waterway

By E. C. Sherman*

The Merrimac Valley Waterway Board, created by the Massachusetts Legislature of 1912, has submitted its final report on the development of navigation on the Merrimac River.

The stream is about 110 miles in length, of which 49¾ miles, from the New Hampshire-Massachusetts line to the mouth at Newburyport, are in Massachusetts. The Board concludes that the river should be improved and opened to navigation by providing a channel 18 ft. deep at mean low water from the sea to Ward Hill, about one mile above Haverhill, and by providing a depth of 18 ft. by means of a channel and by building canals and locks from that point to Hunt's Falls at Lowell. It believes that all this work should be done under some form of coöperation with the Federal Government.

Assuming that the United States will improve the river to the head of tide water at Ward Hill, the Board submits plans and estimates for a project briefly described as follows:

A channel would be dredged in the river from a point near Lowell to the dam at Lawrence to give a depth of 18 ft. below the low-water level of the pool formed by that dam. At Lawrence a lock would be provided so that vessels could be passed by the dam into another channel not less than 18 ft. deep which would follow the river to a point just above Kimball's Island where it would enter the proposed Ward Hill Canal, a direct cutoff around Mitchell's Falls to the channel which, it is assumed, the United States will provide in the tidal section of the river.

Just below Kimball's Island a movable dam would be constructed to form a pool at the highest level possible without interfering with the power developments at Lawrence, so as to reduce to a minimum the excavation in the channel.

It is proposed to make all river channels 200 ft. wide and to give the Ward Hill Canal a width of 100 ft. The width of 200 ft. and the depth of 18 ft. are the same as those recommended for an improved channel from the sea to Ward Hill by Col. Abbot. Both locks will be 350 ft. usable length, 45 ft. wide and will have a depth of 18 ft. over the sill.

The lock at Lawrence would have a normal lift of about 35 ft. and would be located along the north shore of the river. The gates would be of the mitering, girder type, built of steel and having oak quoin and meeting posts, the upper one about 27 ft. high and the lower about 59 ft. high. The operation would be by means of a strut and bull-wheel similar to those used at Panama. The filling culverts would be placed in the side walls, filling and emptying the lock chamber being accomplished through ports near the lock floor, and sluice gates at the ends giving control. To prevent unnecessary use of water at Lawrence, it is proposed to divide the lock into two chambers of about 110 ft. and 240 ft. by means of intermediate gates, so that for any vessel a lock chamber of suitable length may be provided.

The lock at Ward Hill would have a lift of about 8½ ft. and in other respects would be similar to the one at Lawrence except that the intermediate gates would not be necessary and would be omitted.

In addition to the two ship locks it is proposed to provide small boat locks about 50 ft. long, 10 ft. wide and 5 ft. deep for the convenience of pleasure craft and to conserve the water-supply which is particularly valuable at Lawrence for power purposes.

The total length of the Lawrence dam is now 897 ft. After its extension of about 175 ft. at the south end, as proposed, it would be reduced to about 875 ft. by the construction of the locks. It is proposed to excavate a channel immediately below the dam to compensate for the restriction caused by the lock and to further improve conditions by removing the present Broadway bridge, substituting a new double-deck structure on the site of the B. & M. R.R. bridge, to serve for both highway and railroad. This affords the advantage of requiring but one drawbridge over the lock and at the same time eliminates a dangerous grade crossing.

The studies made by the consulting engineer included one with a power plant which might be installed to develop power for lock operation and for lighting the canal and river channels. It would also furnish power to pump back, over the dam at Lawrence, an amount of water equal to that used for lockages to fully compensate the owners of the power rights.

The estimated total cost of carrying out the project prepared by the Board for improving the river from Ward Hill to Lowell, is $5,443,000, which is exclusive of land damages at Ward Hill and of changes in bridges at Lawrence. The total length of the improved waterway would be about 15.3 miles.

The surveys, examinations and estimates for the river channel excavations and for the Ward Hill Canal were made by Geo. W. Wood, of Malden, Mass. The writer was retained as consulting engineer to advise the Board on important engineering questions involved in the investigation, including a study of the existing conditions at Lawrence, the building of locks, canals and dams, the rebuilding of existing structures and to submit a report with plans and estimates for the necessary works.

*Civil Engineer, 6 Beacon St., Boston, Mass.

The Montreal Water-Conduit Break

Interim Report of Board of Engineers as to Emergency Repairs to the 9x8-Ft. Reinforced-Concrete Conduit Which Broke Dec. 25, 1913, as described in Engineering News, Jan. 1, 1914.

In compliance with instructions received from Controller C. H. Godfrey we have investigated, as far as possible up to the present time, the existing condition of the concrete water-supply conduit, and herewith submit an interim report with our recommendations for the immediate strengthening and protection of the section which appears to us to demand instant attention.

We find that for a distance of approximately 500 ft. on both sides of the recent break in the conduit the excavation for the enlargement of the aqueduct* has been carried too close to the conduit for its safety. The effect of this is that the lateral support on the south side of the conduit has been largely removed, leaving an unbalanced load on the north side. This, combined with the fact that the excavation work was carried down to about 5 ft. below the bottom of the conduit, makes an existing condition which the conduit is not structurally designed to meet.

To remedy this state of affairs we have considered various

*The "City Aqueduct" is the open intake canal, used until the reinforced-concrete pipe conduit was built six years ago. The aqueduct is being enlarged, and this work induced the conduit break.—Editor.

methods, and, taking every factor into consideration, we believe that the following will provide the most practicable and prompt method of restoring, as nearly as possible, the original conditions of the conduit and of maintaining an uninterrupted water-supply.

We recommend that a rock-filled timber crib be built at the present foot of the bank adjacent to the conduit along the weakend section, rock and earth to be filled and tamped between the crib and the slope, and the fill to be carried up to the top of the bank over the conduit; the object being to replace the excavated material with new fill and to support this fill with the crib. In the meantime, we repeat our previous recommendations that no further earth excavation shall be done on the north side of the aqueduct, or any blasting permitted in the rock section for the present, also that stone be placed against the slope as rapidly as possible, and that the overload of earth above the conduit be removed, at least to such an extent as will permit the filling of the aqueduct with safety, should the necessity arise for adopting such a measure. It is also our opinion that such removal of bank should be done entirely with hand labor.

It is practically impossible to estimate at all closely the cost of the work we have above recommended, which is to be carried out under conditions which make speed and safety the governing factors. We believe, however, that the cost should be inside of $100,000.

As the work we recommend to be done is urgent, and the contractor for the enlargement of the aqueduct has upon the ground the plant and organization required for doing it more promptly and efficiently than could otherwise be done, we would recommend that, if possible, arrangements should at once be made with him to do the necessary work under such terms and conditions as the city may be able to arrange. In this connection, and without in any way concerning ourselves with responsibility for the present condition of affairs, we may suggest that a fair and reasonable basis of arrangement would be cost of work plus a commission of 10%.

We also recommend that a thoroughly competent superintendent should be placed on the work as the representative of the city with authority to employ the necessary assistants, such as timekeepers, material checkers, etc., and that operations be carried on day and night without intermission and every effort used to push the work as fast as possible.

In addition to the above, we have also considered bypassing the weakened section of the conduit with pipes laid along the bottom of the aqueduct and connected to the conduit through concrete headblocks carried down to rock. We believe, however, that the construction of the crib and fill is the first requirement.

Another matter requiring prompt attention is the removal of the excess load from about 600 ft. of the conduit just east of the present coffer-dam, and the bank of the aqueduct at that point should be carefully watched so that further precautions can be taken at once if necessary.

Montreal, Que.
7th Jan., 1914.

J. A. JAMIESON,
R. S. LEA,
G. R. HECKLE.

To the Board of Commissioners, City of Montreal.

Annual Meeting of the American Society of Engineering Contractors

The annual meeting of the American Society of Engineering Contractors, held in New York, on Jan. 16, had only a small number in attendance, but the report of the Secretary showed that this was not due to a falling off in membership. The number of members of all grades is 639.

The afternoon session was devoted to committee reports and general business. The Committee on Harbor Improvements recommended that in constructing rubble-mound breakwaters, the stone used should be paid for (by the party of the first part) by the 2000-lb. ton, rather than by the cubic yard. This point was given especial emphasis in the case where the stone is transported by lighters, as the weight can be quickly and accurately determined by the load displacement. Concrete breakwater superstructures should be paid for on the cubic-yard basis.

The Committee on Scientific Management (as related to engineering contracting) considered its subject under three headings: History, Scope and Limitations. Under the last heading, in discussing the ignorance of the average contractor of the laws of scientific management, and the equal ignorance of the average efficiency expert of many of the practical laws of business, the following sound statement occurred: "It is necessary either that the contractor absorb the principles of the science, which has been developed largely outside of his own business, or to insist that the efficiency engineer proceed to learn the business to which he proposes to apply his science, before he takes on the work."

The forming of a "Committee of Arbitration" was a subject which aroused much discussion. It was suggested that a list of arbitrators be prepared (these to be appointed, perhaps, by the presidents of the principal engineering societies) so that in the event of disputes among engineers, architects and contractors, over the wording of a contract, etc., impartial and competent judges could be selected promptly and an early decision hoped for.

In connection with the condensation of the multitude of committees carried by the Association, it was decided that the various committees on materials should use their discretion in indorsing the material specifications developed by other societies (e.g., the American Society for Testing Materials), instead of duplicating such work.

The newly elected president, Edward Wegmann, presided at the evening session; and after his brief address, G. H. Perkins, of Warren Bros. Co., of Boston, Mass., gave a talk, illustrated by motion pictures, on road construction. The remainder of the evening was spent in social intercourse, including two humorous motion pictures and a light supper.

Julius R. Wemlinger, of 11 Broadway, New York City, was reëlected Secretary.

The Proposal Agreement between the Massachusetts Institute of Technology and Harvard University*

In this agreement, "the Institute" means the Massachusetts Institute of Technology, and "the University" means Harvard University. It is understood that any action of the President and Fellows of Harvard College shall require the consent of the Board of Overseers wherever such consent is necessary under the laws governing the University.

I. The University and the Institute shall be unaffected in name, organization, title to and rights over property, or in any other way not specifically mentioned in this agreement.

II. The University and the Institute shall coöperate in the conduct of courses leading to degrees in Mechanical, Electrical, Civil and Sanitary Engineering, Mining and Metallurgy, and in the promotion of research in those branches of Applied Science. The courses and research shall be conducted in accordance with the provisions of this agreement and on the site in Cambridge recently acquired by the Institute bordering on Massachusetts Avenue and the Charles River Embankment or on any other site that may be agreed upon should future conditions render an extension or change of site desirable.

III. Subject to the reservations hereinafter set forth the University shall devote to the purposes referred to in Section II the net income of all funds that are credited on its books

*The agreement for coöperation between the University and the Institute, framed in 1905, but which was never carried into effect, was printed in "Engineering News," of April 6, 1905, p. 372.

to the Lawrence Scientific School; also the use of all machinery, instruments, and equipment that are suited to these purposes and that the University does not in its opinion need more urgently for other purposes; also not less than three-fifths of the net income of the Gordon McKay Endowment; also the income of all property that it may acquire hereafter for the promotion of education or research in the branches of Applied Science referred to in Section II; also such further sums as it may from time to time feel able to contribute.

IV. Subject to the reservations hereinafter set forth, the Institute shall devote to the purposes referred to in Section II all funds, or the income of all funds, that it now holds or hereafter acquires for the promotion of education or research in the branches of Applied Science mentioned in that section, and in addition to this as much of the funds, or the income of funds, that it holds for general purposes as is not in its opinion more urgently required for other purposes.

V. Students' fees for courses in the branches of Applied Science mentioned in Section II shall be devoted to the purposes referred to in that section. These fees shall for the first ten years be deemed to be contributed by the two institutions in the proportion of the numbers of the students following these courses in the Institute and in the University's Graduate Schools of Applied Science, respectively, during the year 1913-14. At the end of ten years a different arrangement shall be made, if, in the opinion of the two Corporations, it appears to be more equitable. The fees of students pursuing courses in the subjects referred to in Section II in the University's Graduate Schools of Applied Science at the time when this agreement is adopted shall be unaffected by any change brought about by this agreement. For all other students the amount of the fees for complete courses leading to those degrees of the Institute and of the University that are granted through the operation of this agreement shall be $250 per annum until changed by agreement between the two Corporations. The amount of fees for partial courses and for research shall be determined as may be agreed upon from time to time.

VI. The funds available for education and research in the branches of Applied Science referred to in Section II shall be expended through the Bursary of the Institute in the payment of salaries, the maintenance of scholarships, the care of grounds, and the erection and maintenance of buildings and equipment or otherwise as may be agreed upon from time to time, it being expressly provided that all proposed appropriations shall be approved by the Corporation that supplies the funds, and that buildings shall be erected only from the share of the funds supplied by the Institute.

VII. All members of the Instructing Staff in the departments of Mechanical, Electrical, Civil and Sanitary Engineering, Mining and Metallurgy, who give instruction in courses leading to the degrees both of the University and of the Institute, shall be appointed and removed by the Corporation that pays their salaries after consulation with the other Corporation.

VIII. All students registered at the Institute in the various numbered professional courses covered by Section II that lead to degrees of the University shall be deemed to be prospective candidates for such degrees, unless they signify a contrary intention, and shall be entitled to the same rights and privileges as students in the professional schools of the University.

IX. The President or Acting President of the Institute shall be the executive head for all the work carried on under this agreement. As an evidence of his responsibility in directing it he shall make an annual report to both Corporations. When any future President or Acting President is to be selected, the President or Acting President of the University shall be invited to sit with the committee that recommends the appointment of a President or Acting President to the Corporation of the Institute.

X. As soon as this agreement goes into effect, the Faculty of the Institute shall be enlarged by the addition thereto of the professors, associate professors, and assistant professors of Mechanical, Electrical, Civil and Sanitary Engineering, Mining and Metallurgy, in the University's Schools of Applied Science. These persons shall acquire the titles and privileges of the same rank in the Institute while retaining their titles and privileges in Harvard University, and the terms and conditions of their employment and their salaries shall be unaffected by the change. The professors, associate professors, and assistant professors of the Institute in the departments of Mechanical, Electrical, Civil and Sanitary Engineering, Mining and Metallurgy, shall acquire the titles and privileges of the same rank in Harvard University while retaining their titles and privileges in the Institute, and the terms and conditions of their employment and their salaries shall be unaffected by the change. All professors, associate professors, and assistant professors appointed under the operation of Section VII shall have the titles and privileges of professors of the University and of the Institute, including the right to benefit from the pension systems of both institutions.

Additions to the Faculty of the Institute shall be made by the appointment of professors, associate professors, or assistant profesors under the operation of Section VII, or by the Corporation of the Institute for other purposes. The Faculty constituted as indicated above shall, subject to such directions as may be given by the Corporation of the Institute, prescribe the courses and conditions of entrance thereto leading to all degrees granted by the Institute. The same Faculty shall, subject to such directions as may be given by the Corporation of the University, prescribe the courses and conditions of entrance thereto leading to all degrees granted by the University under the operation of this agreement.

XI. Degrees shall be conferred by the Institute and by the University acting separately on the recommendation of the Faculty referred to in Section X.

XII. It is expressly provided that, as regards the funds and property of the University and of the Institute respectively referred to in Sections III and IV, this agreement shall be subject to any special terms and requirements upon which such funds and property may be held; and any property or funds that may be held at any time by either Corporation under such terms and restrictions as would prevent their use precisely as is indicated in this agreement, shall, nevertheless, be used by the two Corporations respectively for the support, benefit or encouragement of a coöperative effort in the field of education and research in engineering and mining in such manner as may be permissible or in accordance with the trusts upon which they may be held.

XIII. Whereas, doubts might arise as to the legal effect of an omission from this agreement of any provision for its termination, it is hereby provided that the agreement may be terminated either by the University or by the Institute, but that no termination shall be made except upon notice from one party to the other of at least five years unless a shorter time be mutually agreed upon.

XIV. This agreement shall take effect when finally adopted and approved by the Corporation and Board of Overseers of the University and the Corporation of the Institute; and the coöperation referred to in Section II shall begin when the Institute is ready to open courses in Engineering and Mining on the site in Cambridge mentioned in that Section.

The Subway Situation in Chicago

The city of Chicago has failed in its attempt to attract outside capital to invest in a scheme for an extensive and independent underground rapid-transit railway system, and there is now a move to submit to public vote the question of the desirability of establishing a subway system. It will be of interest, therefore, at this time, to review the steps that have led up to the present situation.

For several years past numerous projects and schemes have been advanced for the construction of subways in Chicago, in order to remove the street cars (and in some cases the elevated railways also) from the surface and so relieve the traffic congestion in the streets and at the same time improve the rapid-transit facilities. Some of these projects have been prepared by engineers or boards appointed by the city for that purpose, and others by engineers acting on their own initiative.

In August, 1911, the city appointed a subway commission, composed of three engineers. Its first report (ENGINEERING NEWS, Nov. 16, 1911) presented plans for two separate subway systems: one of these for the elevated railway trains and the other for the surface lines, although the report expressed doubt as to the advisability of providing subways for the surface cars. In 1912, this commission was directed to present a scheme for a comprehensive system of subways extending into the outlying districts, and to be operated entirely independent of existing means of transportation. Its report on such a

system was reviewed in ENGINEERING NEWS of Oct. 3, 1912.

In the fall of 1913, the city, through the above commission, invited bids for such a comprehensive subway system, this system aggregating about 57 miles of line and being estimated to cost $130,000,000 ($96,000,000 for construction and $34,000,000 for equipment. The city's grant of operating privileges is limited by law to 20 years, so that liquidation of the construction debt would have to be based on the prospective earnings of the system during a 20-year term. These conditions were outlined in our issue of Nov. 20, 1913. The bids under this proposition were to be opened on Jan. 5, but the financial conditions and limitations proved unattractive, and no bids were received. The only communication received was a letter stating that a bid (for an entirely different proposition) would be made later by parties backed by foreign capital. As a result of this failure to secure any bids, the Harbor and Subway Commission resigned, on the ground that its services were no longer needed and there was no work for it to do.

This disposes of the project for an underground rapid-transit railway system. There still remains the project for the construction of a more limited subway system for the use of the surface cars and elevated trains, in order to reduce the present congestion of street traffic in and adjacent to the business district. This system has been planned and recommended by Bion J. Arnold (ENGINEERING NEWS, Feb. 23, 1911), and for its construction there is available the city's traction fund, consisting of its 55% share of the net receipts of the street-railway companies. It would be owned by the city and leased to the companies.

The initial part of this system, with one north-and-south through line and an east-and-west loop line connecting with the present river tunnels, is estimated to cost $18,900,000, with $867,000 for equipment. Extensions, to be built as required, would bring the total cost up to $35,300,000 for construction and $1,600,000 for equipment. The cost for equipment, however, would be borne by the companies, under the plan of leasing the subways to them until the expiration of their franchises in 1927.

The question of the city's policy in the matter is likely to be submitted to public vote, and two rival petitions to the Chicago election commissioners are being circulated calling for a referendum vote on the subway problem (as a matter of public policy) at the regular election in April, 1914. One asks that there be a vote on the question of a comprehensive rapid-transit subway system, to be built upon such terms as will insure municipal ownership within 30 years, out of the earnings of the subway. The other petition asks that there be a vote on the question of the construction by the city (using its traction fund) of an initial system of municipally owned subways, to be leased to the street-railway companies and to be extended as required. Both petitions provide for a 5c. fare, and the second includes universal transfers.

NEWS NOTES

A Lumber-Yard Fire, believed to have been of incendiary origin, destroyed about 5,000,000 ft. b.m. of lumber in the yard of E. K. Wood, of San Pedro, Calif., on Jan. 11, according to press dispatches from Los Angeles. The fire was stubborn and its extinction required the combined efforts of the fire departments of San Pedro and Los Angeles.

The British Submarine "A 7" Was Lost with two officers and nine men on board, in Whitesand Bay, five miles from Plymouth, England, on Jan. 16. During practice, the "A 7" sank and failed to rise again, making the sixth of her class ("A") to fail. She is one of a class of nine vessels numbered A 5 to A 13, was built in 1904 and measured 150 ft. in length. Her submerged displacement was 204 tons. Her 600-i.hp. engines propelled her at 16 knots on the surface, and nine knots when submerged.

Production of Portland Cement in 1913 exceeded that of any previous year, according to the estimate of Ernest F. Burchard, for the U. S. Geological Survey, made public on Jan. 22. In the United States 92,406,000 bbl. of Portland cement were manufactured, against 82,438,096 bbl. in 1912—an increase of 12%. The shipments in 1913 were 88,[illegible],000 bbl. as compared with 85,012,556 bbl. for the preceding year—an increase of 4.5%. The average selling price per barrel was higher in 1912 than in 1913. Of the 11 commercial districts, the five highest with their production in barrels and their per cent. of increase over 1912, are as follows: (1) eastern Pennsylvania and western New Jersey, 27,079,000, 9.4%; (2) Illinois and northwest Indiana, 12,406,000, 16.4%; (3) California and Washington, 8,916,000, 21.5%; (4) Iowa and Missouri, 8,427,000, 11.1%; (5) Ohio and western Pennsylvania, 7,704,000, 4.7%.

The Montreal Water Situation has developed considerably since the conduit break of Dec. 25. The emergency proceedings suggested in the interim report of Jamieson, Lea and Heckle, as printed on another page of this issue, are now being carried out. At the same time, to provide the urgent need for some sort of a duplicate supply (both for fire protection and for domestic supply), a steel main is being laid connecting the Lachine Canal to the city's pumping station, so that in case of a failure of the conduit supply the city would not be left dry. An appropriation of $100,000 was made by the Council for this auxiliary main. A further emergency provision is an additional connection between the mains of the Montreal Water & Power Co. and the city mains, whereby, in case of failure of the city supply, some 20,000,000 gal. more can be pumped in from the company's mains than under the existing physical relations of the two systems. The company already had on order additional transformer equipment to enable its pumping plant to be run at full power, and this will be ready for service in a short time. When installed, the company will be able to supply a large part of the city's demand in addition to taking care of its own customers.

Negotiations between city and company for an arrangement under which the city may take over the company's property have been under way. One of the matters discussed was setting a fixed price and a fixed time limit for the purchase. The company's present charter permits the city to expropriate the company at any time, and the company has now a bill in the legislature abolishing this provision.

PERSONALS

Mr. A. D. Millard, Roadmaster of the Chicago, Peoria & St. Louis R.R., at Jacksonville, Ill., has been promoted to be Engineer, with headquarters at Springfield, Ill.

Mr. O. F. Berry, of Carthage, Ill., former Chairman of the Railroad and Warehouse Commission of Illinois, has been appointed Special Examiner, Interstate Commission.

Mr. George F. Maddock, M. Am. Soc. M. E., has been appointed Manager of the department of examinations and reports of H. M. Byllesby & Co., Engineers, Chicago, Ill.

Mr. S. Wolff, formerly Manager of the Cleveland, Ohio, office of the Allis-Chalmers Co., has been appointed Manager of the Chicago, Ill., office of the De Laval Steam Turbine Co.

Mr. Richard C. Harrison, former Second Deputy Commissioner of Docks & Ferries, New York City, has been appointed First Deputy Commissioner, at a salary of $5000 per annum.

Mr. William J. Wood, of Evansville, Ind., former Chairman of the Railroad Commission of Indiana, has been appappointed Special Examiner, Interstate Commerce Commission.

Mr. Edward L. Walker, Assoc. M. Am. Soc. C. E., recently Supervising Engineer, Chief Engineer's Office, Department of Gas, Water Supply and Electricity, New York City, has been appointed Assistant Engineer of the Pennsylvania State Water Supply Commission, with headquarters at Harrisburg, Penn. Mr. Walker is a graduate in civil engineering of the Worcester Polytechnic Institute, class of 1897.

Messrs. Thos. M. Hurburt, M. Am. Soc. C. E., and H. A. Rondo announce the formation of the partnership of Hur-

burt & Rondo, Civil Engineers, with offices at 502 Henry Bldg., Portland, Ore.

Mr. Edward de V. Tompkins, M. Am. Soc. C. E., Consulting Engineer, New York City, has been appointed Second Deputy Commissioner of Docks & Ferries, New York City, at a salary of $5000 per annum.

Mr. E. B. Hall, recently Division Master Mechanic of the Chicago & Northwestern Ry., at Chicago, Ill., has been promoted to be Assistant to the General Superintendent of Motive Power at Chicago.

Mr. L. Earle Thornton has been appointed City Engineer of Pensacola, Fla., by the Board of Commissioners, succeeding Mr. George Rommel, Jr., M. Am. Soc. C. E., resigned as noted in our issue of last week.

Mr. H. E. Obenshain has sold his interest in the Roanoke Iron Works, Inc., Roanoke, Va., and has resigned as President of the company, in order to open an office in Roanoke as a manufacturers' agent.

Dr. Hermann M. Biggs, recently Chief Medical Director of the New York City Health Department, has been appointed Commissioner of Public Health of the State of New York, for three years at a salary of $8000 per annum.

Mr. D. E. Lauderburn has withdrawn as a member of the firm of Vitale & Rothery, Forest Engineers, New York City, and has established an office of his own at 56 Worth St., New York City, for the practice of forest engineering.

Mr. B. Oates, formerly with the Fawcus Machine Co., Pittsburgh, Penn., and recently with Henry Steers, Inc., New York City, has been appointed Mechanical Engineer of the Morris County Crushed Stone Co., Morristown, N. J.

Mr. John F. Hammond, M. Am. Soc. C. E., has completed his work in Oswego, N. Y., as Resident Consulting Engineer on sewerage and sewage-disposal works, and has resumed his practice as Consulting Engineer at 123 Oak St., Richmond Hill, Queens County, N. Y.

Mr. Gustav Lindenthal, M. Am. Soc. C. E., Consulting Engineer, New York City, has been awarded a gold medal at the International Exhibition at Leipzig, Germany, for the design and plans of the Hell Gate steel arch bridge of the New York Connecting R.R., described in our issue of Jan. 8.

Mr. William Walliser, recently Division Superintendent of the Chicago & Northwestern Ry., at Belle Plaine, Iowa, has been appointed Assistant to the General Manager at Chicago, Ill. He is succeeded at Belle Plaine by Mr. B. E. Terpning, formerly Superintendent of passenger terminals at Chicago.

Mr. M. H. Gold, Assistant Engineer of the Seaboard Air Line Ry., at Jacksonville, Fla., has been promoted to be Division Engineer of the Alabama division, with headquarters at Americus, Ga. Mr. Gold entered the service of the Seaboard Air Line Ry. soon after his graduation from the North Carolina Agricultural & Mechanical College in 1908.

William F. Berry, former Vice-President of the Boston & Maine R.R., died at his home in Winchester, Mass., Jan. 9. He was born in Biddeford, Maine, in 1844, and began railway work at 20 years of age as an agent on the Eastern R.R. He was continuously employed by this railway and its successor, the Boston & Maine R.R., until a few months ago.

Mr. Charles E. Burr, Superintendent of the Pennsylvania division of the Delaware & Hudson R.R., at Carbondale, Penn., has been appointed Acting General Superintendent of Transportation, with headquarters at Albany, N. Y., succeeding Mr. Charles E. McKim, temporarily retired on account of ill health. Mr. Burr is succeeded at Carbondale by Mr. C. A. Morgan, Trainmaster.

Mr. Andrew E. Kalbach, a graduate of the United States Naval Academy, at Annapolis, class of 1896, and a former naval officer, has been appointed Deputy Commissioner of Stret Cleaning, New York City, at a salary of $5000 per annum. Since 1908 Mr. Kalbach has been connected with the Rapid Transit Subway Construction Co. and with the New York City Interborough R.R. Co.

Mr. Harold C. Stevens, Assoc. M. Am. Soc. C. E., Principal Assistant Engineer of Johnson & Fuller, Consulting Engineers and Sanitary Experts, New York City, has been admitted to membership in the firm. Mr. Stevens is a graduate of the Massachusetts Institute of Technology, class of 1896, and was formerly Assistant Designing Engineer of the Board of Water Supply, New York City.

Mr. William C. Reeder has been appointed Assistant Director of Public Works of Philadelphia, Penn., and will have the supervision of the Bureau of Street Lighting, City Property, Highways, Street Cleaning, Surveys and Water-Works. Mr. Reeder graduated in civil engineering from the University of Pennsylvania and has served in the enginering departments of Philadelphia for the past 22 years.

Mr. Robert P. Howell, Assoc. M. Am. Soc. C. E., Town Surveyor and Civil Engineer of Phillipsburg, N. J., has been elected one of the five Commissioners of the town, under the commission-plan government. Mr. Howell is a graduate of Lehigh University, and has been Town Engineer for the past 10 years. He has also served as inspector of pipe and castings for the cities of New York and Boston at the Warren Foundry, Phillipsburg.

Mr. Charles H. Eglee, Assoc. Am. Soc. C. E., for nine years General Manager of the Ambursen Hydraulic Construction Co., Boston, Mass., in charge of construction work, has resigned to become connected with the Aberthaw Construction Co., also of Boston, and will have charge of all dam and reservoir work for this company, which has recently added a dam-building division to its other concrete construction departments. Mr. Eglee is a native of Boston and has been a waterworks contractor since 1883, when he was admitted to the firm of Henry Lewis, Contractor, of Boston. In 1885 he established a contracting business under his own name.

Charles C. Riley, General Superintendent of Transportation of the Baltimore & Ohio R.R., the Baltimore & Ohio Southwestern and the Cincinnati, Hamilton & Dayton Rys., at Baltimore, Md., died in Washington, D. C., Jan. 6. He was in his 50th year. Mr. Riley was educated to be a physician, but soon after his graduation from the Central College of Physicians and Surgeons at Indianapolis, Ind., he started railway work as a clerk in the freight office of the Cincinnati, Indianapolis, St. Louis & Chicago R.R. He was promoted through various clerical positions with this railway and its successor, the Cleveland, Cincinati, Chicago & St. Louis R.R. until 1897, when he went to the B. & O. Southwestern.

Mr. Howard S. McNair, former Assistant Secretary and Treasurer of the New Orleans Ry. & Light Co., has been appointed Chief of the engineering department of the United Gas & Electric Corporation, New Orleans, La. Mr. McNair was at one time employed by Mr. J. F. Coleman, M. Am. Soc. C. E., Consulting Enginer, New Orleans. He has been connected with the New Orleans Ry. & Light Co. for the past five years, and was Assistant to the President, Mr. Hugh McCloskey, now President of the American Cities Co. Mr. McNair will have supervision of all the engineering and construction work of the public utilities companies controlled by the American Cities Co. in New Orleans, Birmingham, Nashville, Knoxville, Memphis, Little Rock and Houston.

OBITUARY

W. B. Linsley, former Division Superintendent of the Chicago & Northwestern Ry., died at his home in Escanaba Mich., Jan. 10.

Albert W. Martin, former Superintendent of the Boston division of the New York, New Haven & Hartford R.R., died in a street car in Boston, Mass., Jan. 12. He was 62 years old.

Bernard Corrigan, President of the Kansas City Construction Co., one of the most prominent contractors of Kansas City, Mo., died Jan. 6. Mr. Corrigan was formerly President of the Metropolitan Street Railway Co., of Kansas City.

E. F. Ackerman, Assistant Engineer of the Lehigh Valley R.R., New York City, died Dec. 26, at Johns Hopkins University Hospital, Baltimore, Md. He had been with the Lehigh Valley R.R. since 1896, when he began work as a draftsman.

C. Q. Horton, a bridge contractor of Austin, Tex., was accidentally killed on Jan. 3, at Granger, Tex., by the fall of a portion of a bridge he was constructing. According to a newspaper dispatch Mr. Horton was superintending the erection of a county road steel bridge, when a section of the structure collapsed, killing him instantly.

Wilmer Olin Chrismas, Assistant Engineer, U. S. N., retired, died at his home in New York City, Jan. 12. He was born in 1851, at Valley Forge, Penn., and in the very house made famous as the winter headquarters of George Washington during the most trying period of the Revolutionary War. Mr. Chrismas was educated at Meigs Academy, Pottsdown, Penn., the Philadelphia Polytechnic Institute and the Naval Academy at Annapolis. He was commissioned Assistant Engineer in the United States Navy in 1877 and made many cruises before his retirement in 1887.

Edwin E. Nolan, head of the materials disposition department of the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Penn., died at his home in Wilkinsburg, Penn., Jan. 13. Mr. Nolan's service with the Westinghouse Electric

Co. began in 1887. Subsequently he was made Superintendent of the company's Allegheny factory and there had charge of the building of the first alternating-current generators for the Niagara Falls power plant. In 1898 he was sent to France to establish a factory for the company at Havre. On his return to the United States in 1902 he was placed in charge of the materials disposition department.

Calvin Milton Woodward, Professor Emeritus and Dean of Washington University, St. Louis, Mo., died at his home in St. Louis, Jan. 12, in his 77th year. He was born Aug. 26, 1837, at Fitchburg, Mass. He was educated in the public schools of Fitchburg and at Harvard University, where he graduated in 1860. Soon afterward he became Principal of the high school at Newburyport, Mass.; but his work here was soon interrupted by the outbreak of the Civil War, for he left his school to enlist in the army and ultimately became Captain of Company A, 48th Massachusetts Volunteers. After the war he settled in St. Louis, Mo., and for five years was Vice-Principal of Smith Academy. In 1870 he was appointed Professor of descriptive geometry and dean of the school of enginering and architcture at Washington University. He retired from active work in 1909, having completed 40 years' service with the University. Prof. Woodward was the founder of the St. Louis Manual Training School, and he had been a director of the institution from its foundation to the time of his death. He also served as a member and as President of the St. Louis Board of Education. At various times since 1891 he was a regent of the University of Missouri. Prof. Woodward was a Past-President and honorary member of the St. Louis Engineers' Club, and was one of the most prominent and active citizens of St. Louis.

John Walker Wilkins, a pioneer English telegraph engineer, died Dec. 18, at his home at Kingston-on-Thames in his 87th year. His early training and experience was in civil engineering, but he took great interest in electrical experiments, at a time when electricity was first being put to practical uses. While still a very young man he was associated with William Fothergill Cooke in the construction of railway telegraph lines. Shortly afterward he was appointed Resident Superintendent of Telegraph on the Northampton & Peterborough Ry., the first position of its kind in England. About the same time, in 1845, Mr. Wilkins first began to experiment with wireless telegraphy and is said to have obtained signals between elevated wires 120 ft. apart. He has been credited as having made the earliest recorded experiments in wireless telegraphy; these experiments were described in the "Mining Journal," of London, Mar. 31, 1849. Mr. Wilkins came to the United States in 1851 to make telegraphic installations, but the contractor by whom he was employed became involved in lawsuits with the owners of the Morse telegraph patents, and Mr. Wilkins was compelled to abandon his work in telegraphy. He returned to civil engineering and for a short time was employed by the contractors for the Ohio & Mississippi R.R. Returning to England he was engaged for several years in railway construction in all parts of Europe for Thomas Brassey, the famous English contractor. After returning to England he engaged in other business, but always maintained an interest in engineering and scientific research. He was a frequent contributor to technical papers on a great variety of subjects.

ENGINEERING SOCIETIES

COMING MEETINGS

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 27-29. Annual meeting in Montreal, Que. Secy., Prof. C. H. McLeod, 176 Mansfield St., Montreal, Que.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.
Jan. 28-30. Annual meeting at Peoria, Ill. Secy., E. E. R. Tratman, 1144 Monadnock Block, Chicago, Ill.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Jan. 29-31. Midyear meeting in New York. Secy., E. B. Burritt, 29 W. 39th St., New York City.

NATIONAL LIME MANUFACTURERS' ASSOCIATION.
Feb. 4-5. Annual meeting at New York. Secy., Fred K. Irvine, Chicago, Ill.

IDAHO SOCIETY OF ENGINEERS.
Feb. 5-7. Annual convention at Boise. Secy., I. F. Shaffner, Boise.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.
Feb. 10-11. Annual meeting at Hartford, Conn. Secy., J. Frederick Jackson, Box 1304, New Haven, Conn.

OHIO ENGINEERING SOCIETY.
Feb. 11-14. Annual meeting at Columbus, Ohio. Secy., D. W. Seitz, Columbus, Ohio.

NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING.
Feb. 12-14. Meeting at Chicago, Ill. Secy., J. P. Beck, 72 W. Adams St., Chicago, Ill.

NORTH DAKOTA SOCIETY OF ENGINEERS.
Feb. 12-13. Annual convention at Fargo, N. D. Secy., E. F. Chandler, University of North Dakota, Fargo.

AMERICAN CONCRETE INSTITUTE.
Feb. 16-20. Annual meeting in Chicago, Ill. Secy., E. E. Krauss, Harrison Building, Philadelphia.

IOWA ENGINEERING SOCIETY.
Feb. 18-20. Annual meeting at Council Bluffs, Iowa. Secy., S. M. Woodward, Iowa City, Iowa.

MINNESOTA ENGINEERS' AND SURVEYORS' SOCIETY.
Feb. 24-25. Annual meeting at St. Paul, Minn. President, Wm. Danforth, 411 Hackney Building, St. Paul, Minn.

INDIANA SANITARY AND WATER SUPPLY ASSOCIATION.
Feb. 26-27. Annual meeting at Indianapolis, Ind. Secy., Dr. W. F. King, Indianapolis.

AMERICAN RAILWAY ENGINEERING ASSOCIATION.
Mar. 17-20. Annual convention at Chicago. Secy., E. H. Fritch, 900 S. Michigan Ave., Chicago, Ill.

International Association of Fire Engineers—President Haney has called a meeting of the directors, to be held in New Orleans, La., on Feb. 23, to select the date and to arrange a program for the annual convention of 1914. Suggestions are invited on both questions and should be forwarded to the Secretary, James McFall, Roanoke, Va.

Indiana Engineering Society—The 34th annual convention of the Society will be held at the Hotel Severin, Indianapolis, Ind. The first session (on Jan. 22) is for surveyors only; all county surveyors are urged to be present. At the regular sessions, many engineering committees will report. Among the papers to be presented are the following: "Construction of Concrete Stret and Highway Pavement," C. D. Franks; "Brick and Concrete Road Building," A. W. Blunk; "Testing of Commercial Sands," Prof. H. H. Scofield; "Measurement of Gravel in Piles," O. C. Clark; "Economics of Railway Block Signaling," E. D. Cloud; "Bridge Foundations in Gravel Channels," J. W. Mueller; "Vertical Posts of Bridges and Their Permanent Distortion Due to Secondary Stress," Prof. Albert Smith; "Comparative Tests of Concrete Columns," W. K. Eldridge. The annual dinner is scheduled for Jan. 22. The Secretary is Charles Brossmann, of Indianapolis.

American Electric Railway Association—The mid-year conference will be held in New York, Jan. 29-31. The subjects to be considered are: "Economic Aspects of Regulation Compared with Profit Sharing with Municipalities"; "Effect of Rate of Fare on Riding Habit"; "Inherent Hazards of the Electric Railway Industry"; "Present Day Influence of Labor on Legislation." Among the speakers scheduled are Halford Erickson, of the Wisconsin State Railroad Commission, and F. W. Hild, General Manager of the Portland Ry., Light & Power Co. On Jan. 29, the annual banquet will be held at the Waldorf-Astoria. The Secretary is E. B. Burritt, 29 West 39th St., New York.

Alabama Association of Highway Engineers—At the annual meeting of the Association, in Montgomery, Ala., on Jan. 10, R. P. Boyd, Assistant State Highway Engineer, was elected President. The Secretary is S. J. Cumming, of Gadsden, Ala.

Wisconsin Municipal Contractors' Association—At the sixth annual meeting, at Milwaukee, on Jan. 12, George Stanchfield, of Fond du Lac, was elected President. The Secretary is D. Johnson, of Oshkosh.

Idaho Society of Engineers—The annual convention will be held in Boise, Idaho, Feb. 5-7, and will overlap the conference of the Reclamation Service which will be held Feb. 3-5. The Secretary is I. F. Shaffner, of Boise.

Louisiana Engineering Society—At the annual banquet, in New Orleans, at Galatoire's on Jan. 10, the retiring President, A. M. Shaw, spoke on "The Engineer as a Conservationist." The officers for 1914 are W. H. Williams, President, and James M. Robert, Secretary.

Arkansas Good Roads and Drainage Association—One of the papers presented at the 12th annual convention held at Little Rock, Jan. 14-15, was by the Hon. E. A. Kingsley, ex-state Highway Engineer, and dealt with earth road construction and maintenance. Mr. Kingsley believes that both earth and macadam roads will be in use for many years to come and that, therefore, the problem of their proper maintenance should be solved. One of the main reasons for poor earth roads is lack of system in their construction and upkeep. In summing up, he said that "if the drainage ditches are kept open and clean, the roadway well graded and property crowned after rain, and dragged when ruts appear, the problem of successful earth road maintenance has been solved."

Municipal Engineers of the City of New York—The annual meeting will be held in the Engineering Societies Building, at 8:15 p.m., on Jan. 28. The program includes the reading of the annual report, the President's address, and a lecture by John W. Lieb, on "Leonardo da Vinci, Engineer." Ladies are invited to be present. The Secretary is George A. Taber, 29 W. 39th St.